A. C. Davis

Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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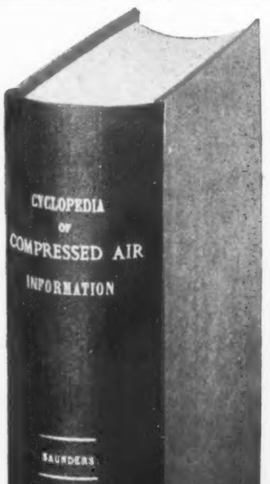

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Compressed Air.

OR

THE COMPRESSED AIR MAGAZINE.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - Editor and Proprietor
J. E. QUINTERO, - } Associates
M. E. VARIAN, }

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Another Instance of Electricity in Coal Mines.

Our attention has been called to a circular letter recently sent out by a mine inspector in one of the Pennsylvania coal mining districts, the purpose of this circular being to call the attention of mine operators to several important provisions of the bituminous mining law and to urge upon them the necessity of a strict compliance with this law in order to better safeguard the lives of their employees.

The letter refers particularly to the sections of this law dealing with means for preventing explosions from accumulation of gases. The first portion refers particularly to the necessity of using locked safety lamps in all places where there is the slightest indication of the formation of explosive gases, and is of interest, but we wish to refer especially to the latter portion of this circular letter which quotes Section 5, Article 5, of the Bituminous Mining Law and relates to the use of electricity in mines. This section reads as follows:

"In all mines or parts of mines worked with locked safety lamps, the use of electric wire and electric currents is positively prohibited unless said wires, machinery and all other mechanical devices attached thereto and connected therewith, are constructed and protected in such a manner as to secure freedom from the emission of sparks or flame therefrom into the atmosphere of the mine."

Commenting on this the circular goes on to say:

"Up to the present there has been no device perfected, so far as known to me, that will positively prevent the emission of sparks or flame from such electric wire or machinery; therefore, whenever they are placed in any such mine, or parts of such mine, they are placed there in direct violation of said law, and I respectfully request you to comply strictly with the provisions of the law."

To our mind this a very important evidence of a serious danger which always surrounds electrical apparatus when installed in coal mines. So certain is this danger as to call forth a very strong remonstrance on the part of mine inspectors to the use of any form of electrical apparatus in mines where there is the slightest chance for the formation of gas.

We have all along contended that an electrical installation in coal mines is not the most approved engineering practice in all cases, and in instances where such plants have been installed with an idea of economy the risk of serious accident has been increased to such an extent that any local economy has been more than off-set, and while in the majority of cases no accidents have resulted from sparking or flaming of broken wires (the accidents being restricted to injury to operators), we believe that the time will come when mine operators will realize that economy, when

looked at from all sides, will mean the installation of compressed air plants.

The circular letter which we have quoted is only one of many evidences of the trend of events towards this conclusion.

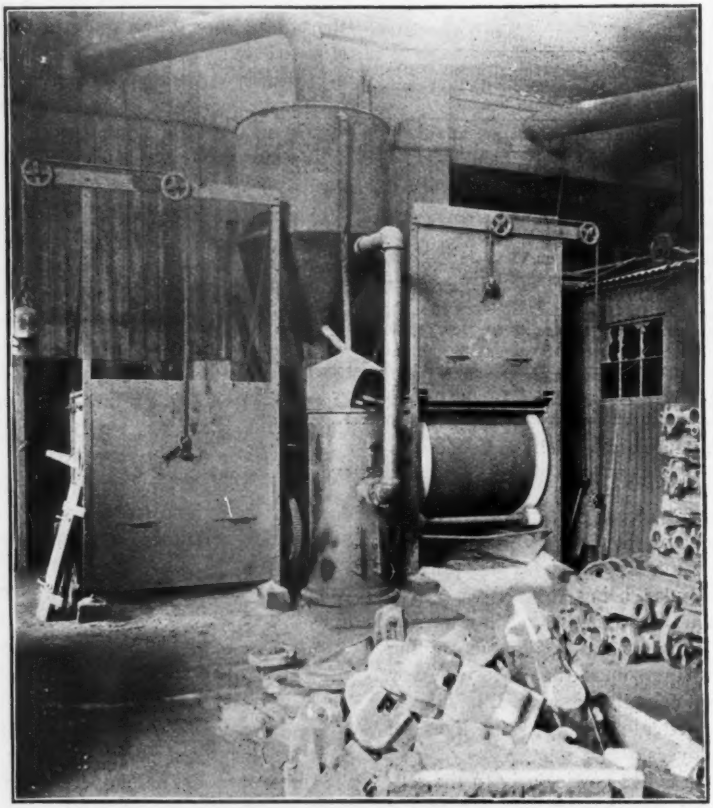


FIG. I—A SAND BLAST TUMBLE BARREL.

Compressed Air in the Machine Shop and Foundry.

BY WILLIAM L. SAUNDERS.

An industry like that of compressed air, which has recently made such strides in its useful applications, may be studied with interest from time to time with something new always available. In the notes that follow, an effort has been made to put together such data on the subject as may be useful to a general manager of a manufacturing company, in ascertaining whether pneumatic appliances which have reached the successful stage are suitable to meet the conditions which exist in his case, and what will be the approximate cost of installation, operation, and maintenance. He may also gain some hint as to whether or not it will pay to invest money in a compressed air plant.

Compressed air and electricity are broad and new fields for industrial research; hence we will always find failures in the field of experiment, and in the literature

on the subject we too often see ideas set forth which are really nothing more than theories, dangerous in themselves, because, being presented to the public in a plausible manner, persons are apt to invest money in them only to find that before reaching the point of usefulness an experimental period and further expenditure of money have to be encountered.

Electricity, having advanced beyond compressed air in its industrial march, appeals to the investor with greater confidence, because of the numberless cases where it has paid to use it. With compressed air there have been too many unreliable experimenters and writers, and both confidence and money have, therefore, been lost.

A single branch of the subject has been selected for treatment here—the use of compressed air apparatus in the machine shop and foundry—and the writer would say at the outset that he does not by any means advocate the adoption of every pneumatic device that is offered. Many of them, in fact, are to be avoided quite as carefully as perpetual motion and other kindred schemes; but there is a wide range through which compressed air appliances will work marked economies.

There are some pneumatic devices whose action is certain and whose limitations are fully known and well-defined, and in adhering to these the shop manager will find means to improve works output and decrease the labour involved in its production.

Taking the matter up logically, let us examine the elements essential to a plant using such standard forms! First we must have the equipment consistently planned after a study of the conditions. Generally speaking, it is best to have the air compressor installed in a central position convenient to boilers and cooling water and where the existing engineering force can take care of it. From this point air pipes are run to the several departments where the air is to be used.

Some idea should be formed of the amount of apparatus to be installed for present wants, the quantity of air it will require, and the location of this apparatus. An allowance should then be made for a natural growth. These data will enable the air mains to be properly proportioned and a compressor, or compressors, selected to give the best results.

In a foundry from one to several sand sifters and rammers can be used to advantage in the preparatory work, and sand blasts, sand blast tumble-barrels, pneumatic hammers and chippers, grinders and scratch brushes in the cleaning and finishing up of the castings, the extent of the outfit depending upon the size of the individual establishment and the class of work it is turning out, that is, whether small, medium or large castings are made.

Any attempt to differentiate between the various makes of such apparatus would be out of place at this time. It is sufficient to say that no one maker has the best of everything, and that several have very good forms of these special machines.

The sand blast tumble-barrel, Fig. 1, speaking from experience with it, is a great improvement over the old forms. Briefly described, it consists of a tumble-barrel revolved by rollers running on its outside, and the whole is encased in a box with a sliding door. At the centre, where the bearing would be in the old form, is an inclined sand blast jet. As the barrel turns, the castings are tumbled again and

FIG. 2—A PNEUMATIC SAND SIFTER.

again in front of the blast, and every part is exposed to its cleaning effect as if held in front of the jet by hand. The illustration herewith represents one of these barrels and shows some castings both before and after cleaning, giving a fair idea of the character of work done.

A feature of this tumble-barrel is the rapidity with which it cleans the castings, an ordinary charge ranging from twenty to thirty minutes. On account of the small amount of tumbling necessary, fragile castings castings can be tumbled without risk of rounding edges, bruising, or projections being worn or broken. Useful as has been the dusty old "rattler," this new form is much its superior. For its

operation about the same quantity of air is required as for the regular sand blast.

The usual sand blast, and, in fact, the tumble-barrels, should always be operated in a special room, built at one side or in a corner of the foundry, or, what is better, in a seperate building so situated that the dust and grit cannot drift into machinery or through the entire foundry to cause wear to the machines and men alike. This "cleaning room," Fig. 5, can be so placed as to avoid any extra handling. But it will be economy to isolate it in any case. The floor should be a grating, and should be connected with an exhaust fan so that dust will be drawn down and carried off into a dust collector.

It is also necessary that the operator be provided with a helmet with a fresh air supply hose attached to it, because, at best, the atmosphere in the sand blast room is filled with an impalpable dust which would be harmful without the breathing helmet. The dust collector is somewhat like a separator, and generally consists of an enlargement in the pipe into which water is sprayed. The dust is caught by the water and alllowed to settle or run off into a drain.

In cleaning out cores and inside spaces the sand blast is indispensable, as it does the work rapidly and far more thoroughly than any other means yet devised. Formerly, with intricate castings, requiring, a great deal of core work, one of the difficult parts of the task was to remove the cores from the narrow parts of the castings. Usually this was done by digging and scraping away with chisels and hooks. Now the sand blast is employed, and it has been found that one of the simple adjuncts will accomplish more than formerly could be done by from six to ten cleaners. Not only does it do the work more quickly, but the casting is left in far better condition for the succeeding machining processes, as scales, burned spots and oxide are cut away without injury to the solid metal. For the best work of the sand blast apparatus pressures ranging from ten to thirty pounds per square inch and a volume of about 120 cubic feet of free air per minute are necessary. Air for operating may be obtained from a low-pressure compressor for this purpose alone, or from the receiver between the high and low-pressure cylinders of a compound compressor used for shop purposes in general.

Pneumatic sand sifters may be regarded as somewhat novel, but several forms have been devised which will prove of service, and where compressed air is in use, or where its adoption is under consideration, the use of these is warranted. One form of such sifter, Fig. 2, consists of a suitable frame supporting a cylinder with a piston connected to a frame which it vibrates rapidly, shaking the attached sieve leaving the moulder free to shovel. These sifters can be fastened to a column or to the wall wherever convenient, or the portable form may be placed close to the work. It is claimed that one man with such a machine can do in one hour as much as he could do in five hours without it. The average air consumption when working is about 12 cubic feet of free air per minute at a pressure of eighty pounds.

Another special device receiving attention in foundries where large work is turned out, or where moderately large pieces are produced in quantity, is the pneumatic sand rammer. Some foundrymen dispute the value of this device, but it unquestionably does remarkable work where the conditions are in any way favorable. Several forms have been brought out, all more or less bulky and crude; but even these made such good records that the device has been perfected and to-day

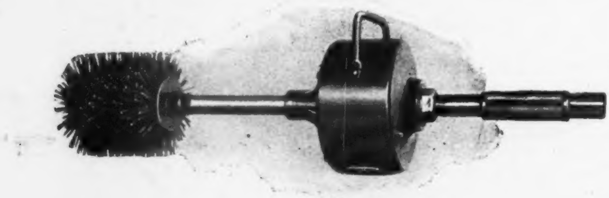


FIG. 3—A PNEUMATIC SCRATCH BRUSH FOR CLEANING CASTINGS.

may be classed as one of the permanent fixtures of an up-to-date foundry engaged in general work of any size. The smallest size of hand rammer made is useful in ramming up flasks, piece ramming on large work, ramming concrete, and similar work. A small valve in the handle puts the machine under perfect control of 250 to 300 blows per minute and uses 15 cubic feet of free air per minute. It has two handles and removable rammer butts, and makes a good record for moderately heavy ramming on loam or ramming up converter bottoms in steel works, etc.

Another type is intended to be worked suspended from some form of crane. It

FIG. 4—A PNEUMATIC SAND RAMMER FOR MEDIUM AND SMALL WORK.

the operator. Complete it weighs 20 pounds, and strikes from 250 to 300 pounds, using 11 cubic feet of free air per minute at a pressure of from 60 to 100 pounds. Fig. 4 shows one of these rammers.

A somewhat heavier form of this device weighs 45 pounds. With air at from 50 to 100 pounds pressure it also strikes from is much heavier and is more powerful than the other forms. The air supply is taken through the upper end of the elevating screw which passes through a block, in turn swivelled to the suspension straps—an arrangement which allows the freest movement.

Pneumatic moulding machines are known and in daily use in many places,

but their value is not fully understood by a large proportion of manufacturers. A typical machine of this class consists of a very substantial table, the standard of which is an inverted air cylinder whose size depends upon the dimension of the work to be done. Over this table is suspended a ramming head or solid back, to the ends of which are attached side rods running down to the base of the machine where they are hinged to allow the ramming head to be swung back to clear the flask. At one side is a three-way controlling valve which admits air to the cylinder or opens the exhaust.

In operation the "flask" is put on the table, filled with sand, the head is swung into position and the valve is turned. The air, under a pressure of 70 to 80 pounds per square inch, then lifts the entire table, with flask, pattern, and sand, up against the head, not with a steady pressure, but forcibly with a blow. Frequently one blow is sufficient, at other times two or three are found necessary, all depending upon the character of the mould. Turning the valve further exhausts the air from the cylinder and allows it to drop. The operator then cuts the sprue holes and turns a thumb-screw to start a pneumatic rapper or vibrator, which frees the pattern from the mould far better than hand rapping. Another lever is then thrown and the flask is stripped or carried free of the pattern. This pneumatic vibrator causes the entire pattern to quiver or shiver in such a way that it is absolutely freed from the sand without enlarging the mould and distort-

FIG. 5—READY TO SAND-BLAST CASTINGS.

ing the shape, thus maintaining the size and effecting a considerable saving in the amount of metal used in the casting.

Following in natural sequence we come to pneumatic chippers for cutting off feathers, risers, sprues and general trimming-up of the rough castings as they leave the sand or the tumble-barrel. Too frequently castings are sent into the machine shop with edges and excrescences which, if removed in the foundry, would save valuable time and reduce the amount of machining necessary, besides reducing the wear and tear on tools and machines alike. Regarding the wisdom of pneumatic chippers for this work there can be no question. These tools are made in different sizes to meet different conditions, but for general foundry trimming a medium size gives the best result.

The number necessary depends entirely upon the class of work; but, generally spaking, there are too few of them rather than too many. There are probably few foundries that could not use from one to five of these handy little cost reducers.

PNEUMATIC HAMMERS.

In a general way pneumatic hammers may be divided into two general classes. Valveless hammers, or those in which the piston is the hammer, and, in its movement, opens or shuts the inlet and exhaust ports; and valve hammers, or those in which there is a distinct and separate moving valve. The former are invariably short-stroke hammers, and find their greatest field in calking and chipping. Their piston speed is high, from 10,000 to 15,000 strokes per minute, being not uncommon.

Valve hammers, on the contrary, are of comparatively slow speed, working at between 1,500 and 2,000 blows per minute. The travel of the piston or hammer is proportionately longer and the blow heavier in like degree. For this reason hammers of this type, or at least the long-stroke ones, are not so well adapted to chipping, serving a better purpose in riveting work.

The piston diameters of pneumatic hammers range from ¾ inch to 1¾ inches, and the length of stroke from half an inch to 5 inches. The lightest hammer weighs about 3 pounds, from which figure the weights run up as high as 26 pounds. Pneumatic hoists of various kinds occupy prominent positions in the foundry. As an example of this form of compressed air apparatus Fig. 6 is of interest, representing a corner of the foundry of the Lidgerwood Manufacturing Company. Three overhead cranes span the spaces occupied by pneumatic moulding machines and enable the heavy flasks to be picked up, placed in the machines, turned over and taken away with the least handling and in a minimum of time. Each of these cranes has a capacity for lifting 2,000 pounds to a height of 6 feet. They are set perfectly level, and have bushed bearings so that they will roll at the slightest touch. In the same works is another foundry crane with a span of 48 feet and a capacity of 5,000 pounds. The hoisting is done with an air hoist having a 10-foot lift attached to a trolley actuated by hand ropes from the floor. The crane travel is obtained through electricity power, the motor being operated from the floor also by conveniently arranged hand ropes. This is a most convenient crane for general use.

It is claimed that the air hoist will do about half again as much work as any other form of hoist for lifting copes, drawing patterns, and shifting cores. In any case, its slow, steady movement closely resembles hand lifting, and as such hoists are under the most perfect control of the operator, permitting the most delicate handling—an essential in handling cores and moulds—they are most useful devices in the foundry. Hoists of this type are made in almost every size, from the smallest to those lifting as much as 10,000 pounds. Generally, they have a lifting speed of from 10 to 36 feet per minute. With the air hoist we may leave the foundry and enter the machine shop, for we now have our castings made, cleaned and trimmed, ready for the lathe, planer, milling machine or other tool, as the case may be. One crucial factor in the economical administration of a machine shop is first to have as few men as possible involved in any given operation, and, second, to keep every man and every machine busy on productive work every minute of the working day.

The speed of operation of a given machine is fairly well fixed, especially when operating steadily on a certain class of work, making, for instance, the same piece day after day. The number of machines a man can operate is fixed, in some places by physical limitations, in others by the dictates of labor unions. In the former

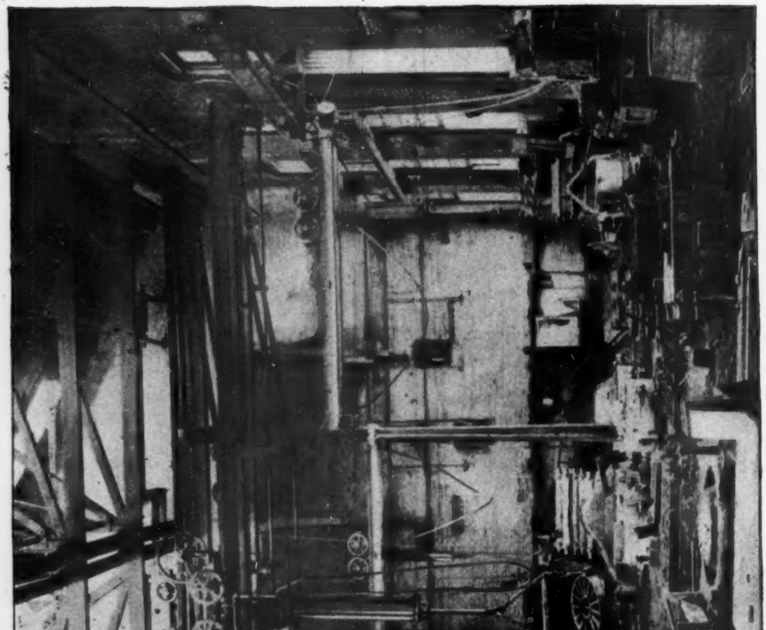


FIG. 6—PNEUMATIC HOISTS AND CRANE IN THE FOUNDRY OF THE LIDGERWOOD MFG. CO., BROOKLYN, NEW YORK.

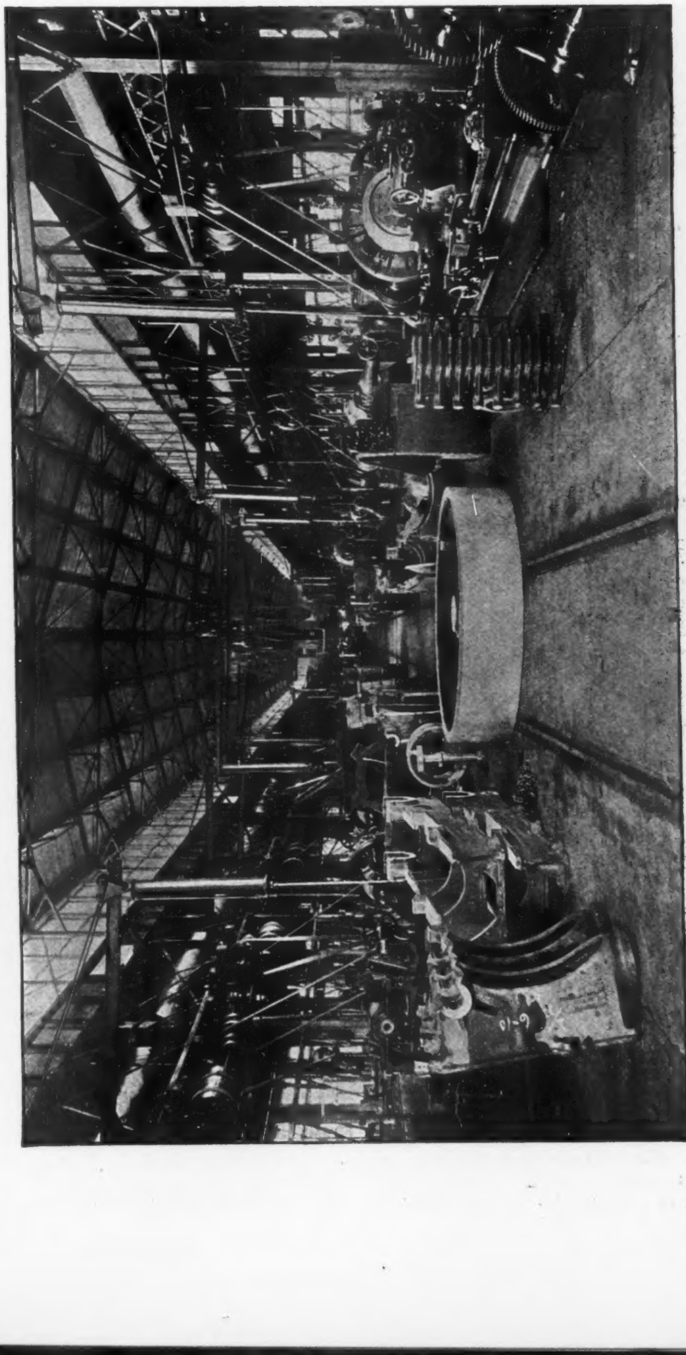


FIG. 7—PNEUMATIC HOISTS ON SWINGING BOOMS AND A PNEUMATIC TRAVELLING CRANE IN THE SHOPS OF THE INGERSOLL-SERGEANT DRILL CO., AT EASTON, PA., U. S. A.

case and where the pieces to be handled are heavy, a means for handling them decreases the idle time of each man and machine, besides lessening the actual physical wear on both operator and tool. The old way of calling an operator from a neighboring machine when a change of work was to be made, lifting the finished piece out and putting in a rough piece, has passed away forever in progressive works, and now the plan shown in Figs. 7 and 9 must be used if it is desired to keep up with the march of progress. These two illustrations represent two types of air hoists employed in the works of the Ingersoll-Sergeant Drill Company, at Easton, Pa., U. S. A.

Fig. 6 shows the familiar single straight-away lifts, hung from swinging arms and arranged to life the smaller pieces and swing them over lathes, planers, or other tools. The same picture shows a large travelling crane, also operated by air. This spans the shop and handles the heaviest pieces with ease. Air to operate this crane is supplied by a hose which is suspended from special hangers along the centre of the shops, and loops up or straightens out according to the direction in which the crane moves.

Fig. 9 represents several more compact forms of hoist in which the cylinders are placed horizontally. The piston in each has a rack cut in it which engages a gear on the shaft of the winding drums. This form, as will be seen, is suitable for use in a shop with fairly low ceilings. The illustration represents several of these hoists mounted on iron beans running transversely across the shop over the machines.

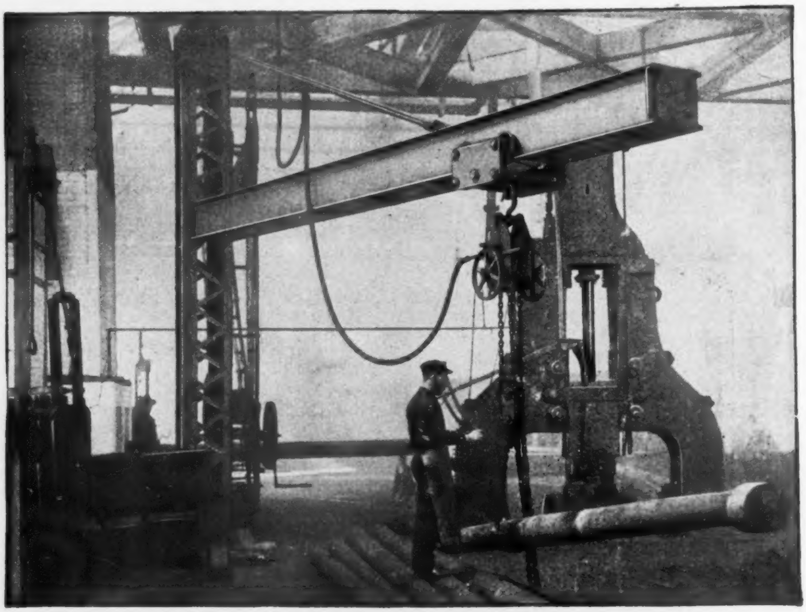


FIG. 8—A PNEUMATIC CHAIN HOIST IN A FORGING SHOP. MADE BY THE EMPIRE ENGINE & MOTOR CO., ORANGEBURG, NEW YORK, U. S. A.

The purpose of this form of hoist is very well shown. Castings or other pieces too heavy for a man to lift are easily picked up from the aisles and carried over to any machine where they are held until properly centered; or the finished pieces are quickly lifted from the lathe and placed on the floor out of the way, without the operator touching them.

In another department of the same works long-cylinder pneumatic hoists are mounted on swinging arms, giving them a

considerable range. Another type of pneumatic hoists uses a small motor and a differential system of gears, giving it greater lifting power than is possible with the direct lift with the same amount of air. Fig. 8 shows such a hoist as used in a blacksmith shop to handle steel bars in and about the hammer. This class of work is a severe test under which these machines stand up admirably. Unlike electrical apparatus, dust and grit cannot hurt them beyond increasing the frictional wear.

The application of an air motor to the usual form of crane drum, consists of a reversible motor, enclosed to protect it from dust and dirt, geared to a winding drum in the same way that an electric motor would be used. This arrangement can be mounted on the boom of a crane and makes a very satisfactory form for yards, or foundry and forging shop cranes. The same motor is often bolted to the cross beams of a travelling crane when a shop travelling crane is desirable. In this case the hose loops up or straightens out as the crane moves along. A revolving pneumatic crane is a form of yard crane for loading or unloading cars or trucks. It can also be used in a machine shop, foundry or elsewhere for placing pieces in machines.

We next come to the use of compressed air for operating special tools, such as drills, boring machines, flue-beaders and millers. At the present time there are a number of excellent forms of pneumatic drills on the market. These are made in different sizes for large or small work. One of their chief claims is the fact that these are easily portable and may be used in out-of-the-way places where other forms of drills could not be applied; or they permit drilling to be done on large pieces where they stand, without moving such pieces about, thus saving time and heavy lifting apparatus. In other words, the tool is taken to the work instead of the work being brought to the tool.

By the use of such drills holes may be put in, ranging from 1/4 inch to 3 inches, at a rate many times that possible by hand. The smaller sizes are very handy for putting on cylinder casings, name plates, and for general finishing work in and about large machines. They are extremely light and compact, use very little air, and are remarkably durable. The larger sizes, too, find a wide range of uses in any machine shop. The table above shows what some of these drills will do.

All these pneumatic tools may be provided with chucks or taper sockets, so that a variety of tools can be used. Once installed, they constantly suggest new uses, and prove their value from the start. In the boiler, machine, and other shops pneumatic tools of various sorts are installed for cutting stay bolts, reaming, and drilling out boiler tubes, expanding new tubes, riveting, etc. A variety of other uses, more or less novel, have been introduced from time to time, all effecting marked savings in the respective operations to which they are applied.

Riveting may be regarded as apart from machine shop work, but here and there special work is turned out on which these tools can be used to excellent advantage.

The table entitled, "Results Obtained with Pneumatic Tools," given further on, is of interest and value as giving a definite statement of the saving in cost and time which may be effected by the use of pneumatic tools of different kinds. It is, as far as the writer is able to determine, accurate, and may be used in estimating on results to be obtained.

From a study of your product, conditions and process of manufacture in the light of the data given, it will be possible to determine upon what apparatus will be applicable to your case. Having selected the types, sizes and number of pneumatic tools or apparatus you want, the total quantity of air necessary for immediate use can be determined. Allowance should be made for an increased demand, which

WORKING RESULTS WITH PNEUMATIC DRILLING MACHINES.

				No. 1	Machine.						
Drilling	1/2-inch	hole	through	1 1/4-inch	mild	steel	plate,	3	minutes,	15	seconds.
"	3/4	"	"	1 1/4	"	"	"	4	"		
"	1	"	"	1 1/4	"	"	"	6	"	25	"
"	1 1/4	"	"	1 1/4	"	"	"	8	"	10	"
				No. 2	Machine.						
Drilling	1/2-inch	hole	through	1 1/4-inch	mild	steel	plate,	5	minutes,	20	seconds.
"	3/4	"	"	1 1/4	"	"	"	7	"		
"	1	"	"	1 1/4	"	"	"	11	"	30	"
"	1 1/4	"	"	1 1/4	"	"	"	13	"		"

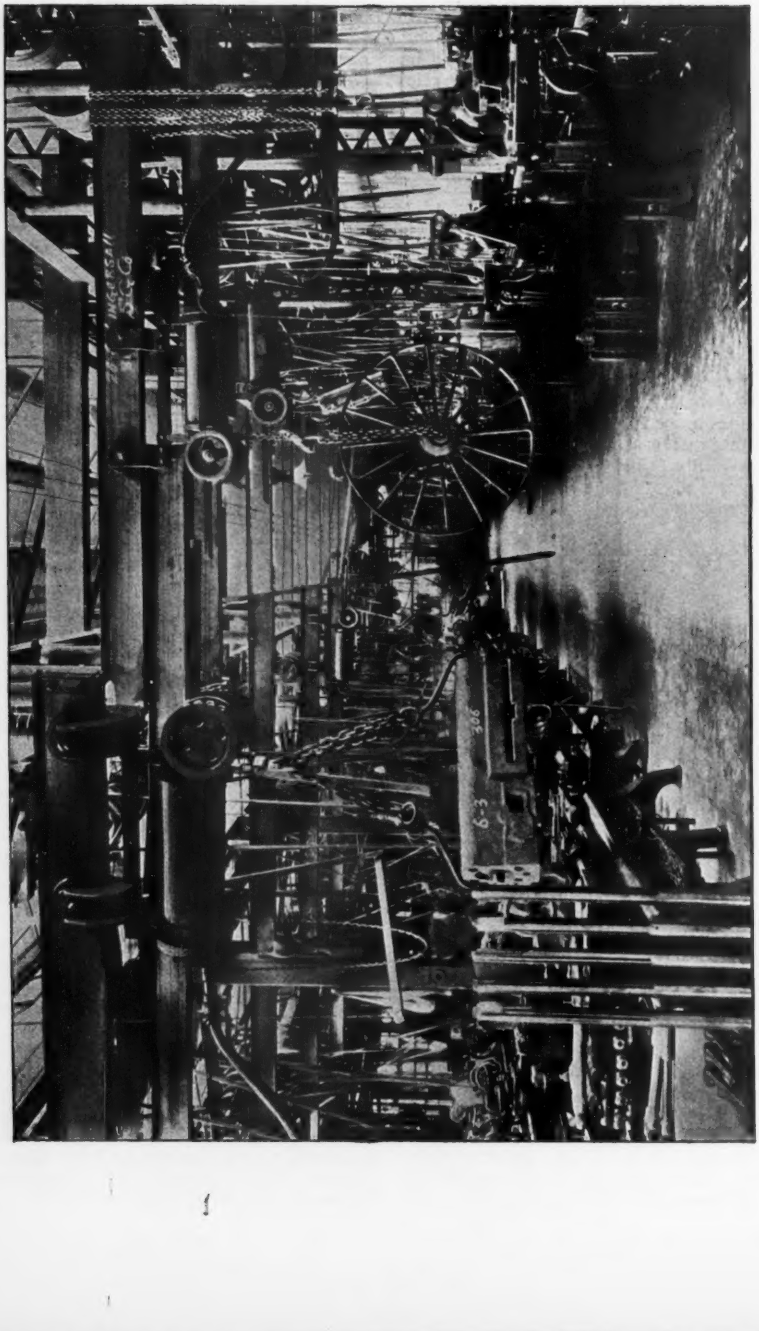


FIG. 9—OVERHEAD HORIZONTAL PNEUMATIC HOISTS FOR HANDLING MACHINE WORK IN THE SHOPS OF THE INGERSOLL-SERGEANT DRILL CO., EASTON, PA., U. S. A.

invariably results after a plant of this kind is installed. The sum of these quantities determines the capacity of the compressor or compressors necessary.

Having determined on the number and location of the tools and the volume of air necessary, a piping or transmission system should be laid out, based on this information. Starting from the location of the compressor, the piping should be run as direct as possible to the shop or shops where the air is wanted. Turns, elbows and joints should be avoided as much as possible, as each of these imposes a certain amount of resistance to the free flow of air, and hence entails a loss of pressure. Where these cannot be avoided long bends, Y branches, and 45-degree elbows should be used.

The table, given further on, entitled "Friction of Air in Passing Through Globe Valves, Elbows and Tees," shows the importance of this point and gives, in feet of straight pipe, the additional length which will cause a reduction of pressure equal to that caused by globe valves, elbows and tees.

Generally, the air mains are run overhead, along the roof trusses close to main columns, down which branch pipes are run at frequent intervals to within a height of about 4 feet above the floor. These branches are usually closed by globe valves, fitted with a nipple to which the flexible hose may be attached. This arrangement admits of the greatest flexibility and permits the entire shop floor to be served with short lengths of hose.

Valves should be avoided as far as possible, as they also offer resistance to the free flow of the air. Where necessary, a type should be selected which has a wide opening without offsets or crooked passages, except in the smaller sizes, where, though desirable, these refinements are not ssential.

In erecting piping, full lengths should be used, care should be taken to avoid couplings and joints, and the work should be done as thoroughly as with steam mains. Joints should be leaded, or, if flanged joints are used, gaskets should be carefully cut and fitted. This seemingly excessive care will pay for itself many times over in the saving of air. It should be borne in mind that every 5 cubic feet of free air require one H. P. for compression to 100 pounds per square inch. The pipes should be firmly supported, to avoid vibration or working; but expansion joints are not necessary, as the temperature of the air in the mains remains practically constant at about that of the shop interior, unless it is conveyed some distance in exposed pipes.

In some cases where the works are scatered over a considerable area it is necessary to put underground the mains leading to the remote shops. For this purpose they may be laid in the ground the same as water mains or drain pipes, or they may be supported in tunnels,

RESULTS OBTAINED WITH PNEUMATIC TOOLS.

Tool	General Character of Work.	Saving — Per Cent. of Cost.	Saving — Per Cent. of Time.
Pneumatic hammer	General foundry work—chipping	67-75	67-75
" "	Riveting on mud ring and fire-box	67	..
" "	Chipping flue sheet	84	75
" "	Beading flues	75	75
" "	General boiler shop work	60	..
" "	Cutting out broken fire-box stays	70	70
" "	Cutting off stay-bolt heads	58	..
Riveter	Boiler riveting	66	50
Drill	Drilling saddles	70	70
"	In general machine shop work	75	75
"	Drilling for stays	50	50
"	In general boiler-shop work	75	75
"	Facing steam pipes	75	75
"	Tapping for stays	65	..
"	Reaming crown sheet	70	..
Breast drill	General work	90	90
Staybolt nippers	Cutting off stays	73-90	75-90
Driving-box press	Pressing brasses	68	..
Paint sprayer	Painting box cars	67	67
" "	Painting car trucks	87	87
Paint burner	Cleaning off passenger cars	67	67
Sand blast	Cleaning tanks	90	83
Air jet	Cleaning cushions	50	50

boxes, brick ducts or the like. This however, is not essential. More often the pipes are placed on the ground surface or supported along the sides of buildings. Where the lines are long and exposed to the outside air, it is well to put in drip tanks or give the pipes enough slope to drain towards low points, where traps or drip loops should be put to take care of any moisture which may collect. These traps should be drained from time to time, either automatically or by hand. The reason for this is obvious when it is remembered that compressed air, as usually produced, contains moisture which will precipitate when the air comes in contact with cooler sections of the pipe line. In any event, especially if the system is permanent, as is the case with a factory, all mains, both inside and out, should be securely supported and protected from material falling on them, rust and other abuses.

A valuable feature of such a system of piping, to which attention should be called, is its utility in case of fire. For this purpose connection may be made to a suitable water supply, either city, private reservoir or fire pump. On a prearranged signal, the air can be shut off and the water turned on, affording at once an abundant supply within a few feet of any part of the works in addition to any regular hydrant and sprinkler system.

When air is transmitted some distance to scattered shops, it is a good plan to place a receiver tank where it enters the building and to connect the shop piping system to this, the object being to reduce the velocity for a minute or so and permit any moisture to be precipitated, as already explained. The receiver also acts as a balance spring and assists in maintaining a constant air pressure in the mains and at the tools. But it is not necessary, nor advisable, to have this large enough to act as a reservoir.

Sometimes when the air has been transmitted long distances, it is reheated after entering the building, and its temperature is considerably increased, with a resulting increase in volume. This reduces the velocity of the air flowing in the transmission main. It is stated that for short distances, not exceeding 500 feet in the case of a given pipe-line, the same results may be expected with air as with water; but for longer distances the efficiency of air transmission increases considerably. In any case, reheating is advisable where motors, hoists or other devices are employed which use a considerable volume of air expansively. Average experience shows that by this means the available air may be increased from 20 to 40 per cent.

The question of best size of mains is one calling for the balancing of a number of factors. When the actual amount of air to be used has been settled upon, the drop in pressure becomes the next point of importance. The smaller the mains, the greater the drop, the same as with the transmission of electricity; but, unlike electricity, an increase in the size of the line works a double advantage, for it at once reduces the loss in pressure, and the larger the pipe, the greater the reservoir capacity.

A "rule-of-thumb" to use in laying out piping systems for small plants is to avoid all pipes less than ¾ inch and not exceed in diameter the size of pipe given by the maker of the compressor as the diameter of the discharge pipe. In case two compressors are used, naturally the pipe from the receiver to where the air is used would have a section double the discharge area of the two compressors. The largest pipe should be nearest the compressor or receiver, and the size should be reduced after each branch. The ¾-inch size refers to the cylinder branches to which the flexible hose is attached.

It is well to insist on an inspection of the piping system at regular intervals to avoid leaks which are wasteful and altogether unnecessary. On account of es-

FRICTION OF AIR IN PASSING THROUGH GLOBE VALVES, ELBOWS, AND TEES.

GLOBE VALVES.

Diameter of pipe, inches.....	1	1½	2	2½	3	3½	4	5	6	7	8	10
Additional length, feet......	2	4	7	10	13	16	20	28	36	44	53	70

ELBOWS AND TEES.

Diameter of pipe, inches.....	1	1½	2	2½	3	3½	4	5	6	7	8	10
Additional length, feet......	2	3	5	7	9	11	13	19	24	30	35	47

caping air being harmless and invisible, it is often the case that leaks are tolerated which, if water or steam were used, would bring severe criticism on the engineering staff. When it is remembered that a pipe or reservoir containing air at 100 pounds gauge pressure will leak about 6½ cubic feet of free air per minute, or 3,870 cubic feet in ten hours, through a 1-16 inch hole, which means something over one horse-power, the importance of

FIG. 10—A PNEUMATIC CHAIN HOIST MADE BY THE INTERNATIONAL PNEUMATIC TOOL CO., LTD., LONDON.

a tight piping system is apparent. Ten or a dozen such leaks will constitute quite an item, and one which can be avoided entirely by proper inspection when erecting, and a little care from time to time afterwards. We have now traced the subject backward from the use of compressed air through the means of transportation to its origin, and it now remains to treat only of its production. There are a few places where compressed air can be produced by means of the hydraulic or falling water system, which may be called the reverse of the Pohl(air lift pump. There are other places where compressed air can be produced by water power-driven compressors, and there are many opportunities where compressors of this sort could be installed and the power transmitted long distances. Many such compressors are in operation in mountainous districts for mining plants. But by far the larger number of factories are so situated that air must be obtained by means of steam compressors, or belt or electrically-driven machines, and the writer will, therefore, confine himself to these types.

On the proper selection of the air compressor is dependent very largely the entire success of a compressed air installation. The compressor is the source and regulator of the power, and as all the working apparatus and the final results rest on the character of the compressor, this certainly should not be the weakest link in the chain. Often, after a due regard of the features already mentioned, works managers neglect the pivot on which turns the entire plant and install a cheap or inefficient machine. An air compressor is a machine very different from a pump or even a steam engine, both in design and construction. Many things are permissible in steam engine construction which should not be tolerated in an air compressor, especially if intended for high pressures. It is doubtful if most people and many engineers realize this point, but it is a fact that cylinders, coolers, pipes and other parts apparently good and which, if used for steam pumps or engines, would pass a careful inspection, must often be rejected for compressed air service because they are porous and allow air to leak through.

It must be remembered that the compressor becomes part of the central power plant, the shutting down of which for twenty-four hours, resulting from a serious accident, may cause as much loss to the user as would half pay for the machine. Constant repairs, even though each single one may be small in itself, when added together may more than equal the extra amount in the cost of a better compressor at the start. It is possible and often wise to experiment with the small things about works in an effort

to reduce costs; you can afford to buy several hundred files of some new make, or two or three pneumatic tools of this make or that, and give them a test, because these are incident to the business. But the compressor, like your boiler, forms part of the heart of your establishment, which must throb whenever called upon, and you cannot afford to experiment with it. The safest rule in this respect is to get the best, but do not expect to get it as cheaply as the inferior article. Another point to bear in mind when selecting a compressor is to allow the manufacturer to advise you, presuming that you are dealing with a reputable concern. Many people fail to realize that it is to the compressor builder's interest to satisfy the purchaser. All the types of compressors he makes will compress air, but each type is designed for a certain class of work, and he knows better than you which machine will best fulfill your wants. Anything that compresses air is not an air compressor from your standpoint. Air brake pumps compress air, but they use from four to five times as much steam as a regular air compressor

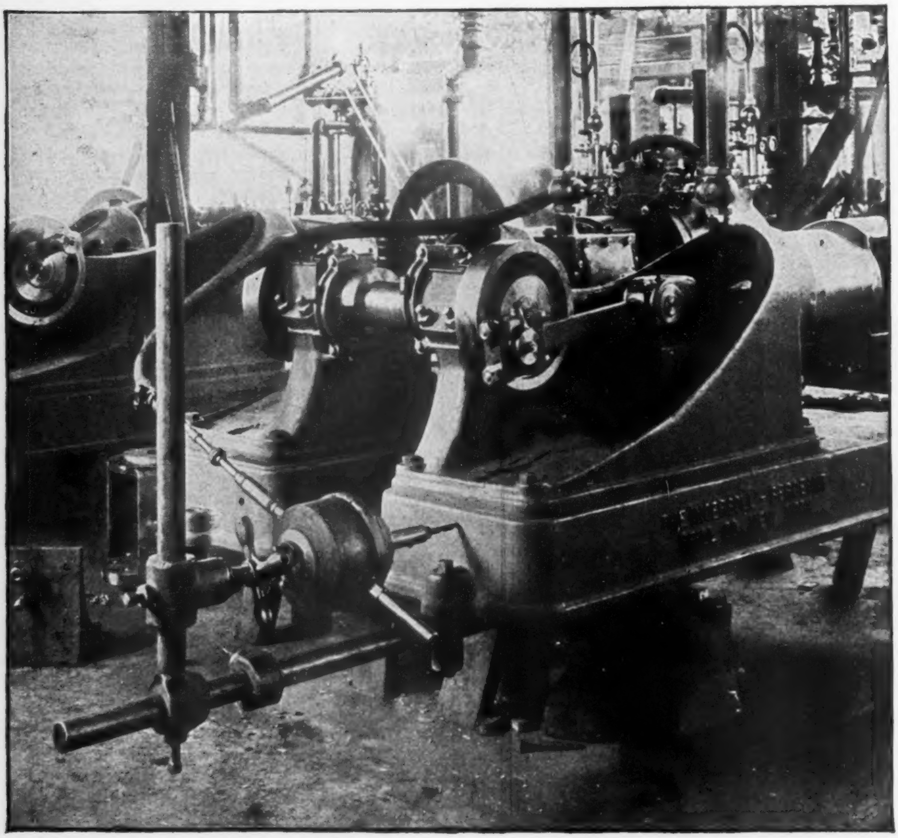


FIG. II—A METHOD OF MOUNTING A PNEUMATIC DRILL, ILLUSTRATING ITS PORTABLE CHARACTER.

APPROXIMATE DATA ON WEIGHTS, CAPACITY, COSTS AND OPERATING EXPENSES OF STANDARD AIR COMPRESSORS ON A BASIS OF 100 LBS. AIR PRESSURE (GAUGE AT RECEIVER) AND 100 LBS. STEAM PRESSURE (AT THROTTLE).

Type of Compressor.	Form of Valve Used.	Steam Consumption lbs. per H.P. per Hour. Non-condensing.	Steam Consumption lbs. per H.P. per Hour. Condensing.	Weight of Compressor per cu. ft. of free Air Piston Displacement.*	Compressor Capacity in Cubic Feet of Free Air (Piston Displacement.)	Cost of Compressor per Cubic Ft. of Free Air Piston Displacement.*	Cost of Compressor per Indicated H.P. Steam 100 lbs.	Cubic Feet of Free Air (Piston Displacement) per 1 H.P.†	Total Cost of One Cubic Foot of Free Air Piston Displacement. Considering a 10-Hour Day, Coal at $5 per Ton, Usual Labor, Depreciation and Interest Expenses. ††
Straight Line	Simple-slide and Meyer's	35	28	53 to 29	24 to 1375	$17.00 to $4.50	$89.00 to $22.00	4.9 to 5.	.002 cts. to .004 cts.
Duplex type self-contained	Meyer's adjustable	35	28	76 to 28	50 to 470	18.00 to 5.10	90.00 to 26.60	4.8 to 5.	.007 cts. to .004 cts.
Duplex extension frame	Meyer's adjustable	35	28	34 to 24	345 to 2200	7.00 to 3.00	32.00 to 24.00	4.6 to 4.7	.003 cts. to .004 cts.
Compound extension frame	Meyer's adjustable	29	20	43 to 32	320 to 1900	9.00 to 4.00	47.00 to 25.00	5.5 to 6.	.0038 cts. to .002 cts.
Corliss compound steam duplex air	Corliss	—	20	75 to 53	550 to 5700	7.00 to 4.30	41.00 to 21.00	5. to 4.8	.0029 cts. to .0017 cts.
Compound steam compound air	Corliss	—	18	71 to 47	600 to 3700	7.80 to 4.70	42.00 to 23.00	5.3 to 5.7	.003 cts. to .001 ct.

* Not including condenser. † Working full load. †† Considering full output.

of the same capacity requires. Some one in your neighborhood may have a small compressor of given make running a sand blast, but it does not follow that the same concern will build for you a larger compressor to work as well.

The rapid increase in the use of compressed air has brought into the field new concerns, but you need not feel that they were born, Venus-like, "full-grown." They are learning by experience something which cannot be injected, like opium, with a hypodermic syringe. Nor does it follow that the oldest is the best, for sometimes the "old-fogy" element creeps into compressors, as well as into other things.

Many manufacturers in buying supplies will look ahead weeks and months and lay in an ample supply of raw materials. It may be a thousand tons of coal in excess of what is wanted, because prices are low, or it may be a six-months' supply of pig iron or the like; but when they come to buy an engine or an air compressor they almost invariably buy only what is needed for present wants. New uses for the compressed air arise constantly, and devices formerly driven by steam, water or electricity, or worked by hand, are found to operate better with air, so that in a surprisingly short time the capacity limit of the machine is reached, and often exceeded, with the result that, without much thought, the compressor is criticized for poor performance when really it is overworked, and hence abused, and a new and larger machine must be bought, the total cost of all this being greater than the cost of the larger machine would have been in the beginning. It is always better to work a little under the rated load and speed.

In discussing air compressors, remember that the manufacturers' invariable rule is to rate their capacities according to the theoretical output of the cylinder, making no deduction for piston rod clearance, friction, heating, or slip. It should be distinctly understood whether theoretical or practical capacity is given. The table, referring to the approximate weight and capacity of air compressors, will be of assistance in figuring on costs of installation and operation; but the cost figures should not be taken too literally, as they are intended to give maximum values which are safe.

The style of compressor to be selected depends upon what may be termed local conditions, that is, whether water-power is available, or whether electricity can be obtained at a reasonable rate, or is produced in a central power station and transmitted to several shops; or whether it is desired to use a belt compressor or a steam-driven type. Compressors designed for each of these conditions are available in the market, and in various modifications of each class.

In conclusion it may be of interest to know the experience of a few large concerns who have adopted compressed air apparatus. One of these is the Passaic Rolling Mills of Passaic, N. J., a concern employing about 1,200 men, with a monthly output of about 5,000 tons of structural material. A complete system was installed, with an air compressor conveniently placed and air mains run to various departments scattered over an area of about twenty-five acres. Air is used for almost every variety of work that can be found about an establishment of this character. In connection with the

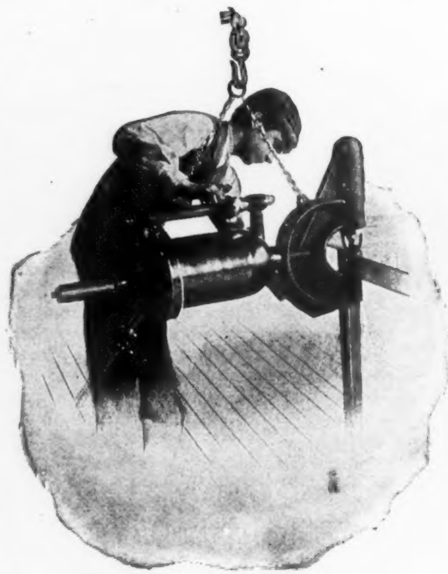


FIG. 12—A PORTABLE PNEUMATIC PUNCH MADE BY MESSRS. F. F. SLOCOMB & CO., WILMINGTON, DEL., U. S. A.

transfer tables and rolls the use of air permitted four men doing the work formerly requiring thirteen, and trebled the capacity of the roll. The cold saws operated in conjunction with the rolls were arranged to be elevated by air. Forty cylinder hoists, twelve riveters, and two chipping tools were also installed, and have been giving excellent satisfaction.

A second case, of a different type of plant, which could hardly be called a machine shop, yet serving as an example of the utility of compressed air, is that of the Tide Water Oil Company, of Bayonne, N. J., where fourteen pumps and other machines, all previously driven by steam, were arranged to be driven by compressed air, with a saving which, to say the least, was remarkable, as the necessary boiler capacity was reduced 178 H. P. by the introduction of the central plant. In this way a yearly saving of $4,450 was effected. Another example is the repair plant of the Manhattan Elevated Railway, in the city of New York. In this plant a number of air hoists and pneumatic cranes were installed, enabling one man in one minute to do work which formerly required two men four minutes.

Still another example, and perhaps one more generally interesting, is furnished by the Baldwin Locomotive Works, of Philadelphia. The present equipment of compressed air shop appliances at these works consists of the following:

A generating plant of ten compressors of various types aggregating 450 horse-power, according to the builder's rating. These compressors range in size from 6 horse-power to 80 horse-power capacity. They are run night and day up to their full capacity, and the actual power developed is generally considerably above the builder's rating. Local conditions render it impossible to utilize a central power station. It was, therefore, necessary to locate the generating plants at three distant points, the supply of air from two of

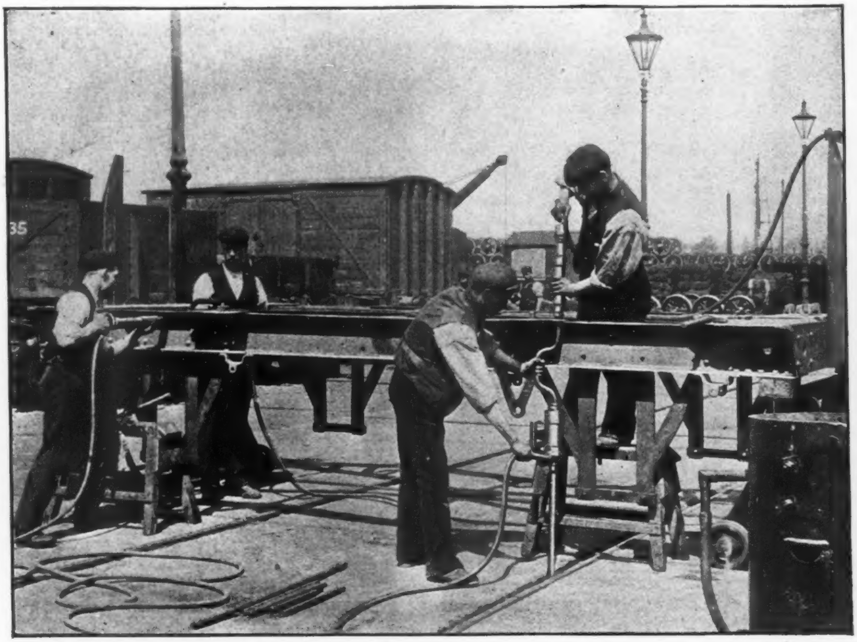


FIG. 13—A PNEUMATIC RIVETING HAMMER AND HOLD-UP AT THE TEMPLE MILLS WORKS OF THE GREAT EASTERN RAILWAY. MADE BY THE NEW TAITE HOWARD PNEUMATIC TOOL CO., LTD., LONDON.

these stations being connected, and the third being entirely independent of the other two. Nine air reservoirs are installed in connection with the compressors, having an aggregate capacity of 1,650 cubic feet with a maximum pressure of 90 pounds per square inch.

There are in operation 115 drills, of which 83 are in use in the boiler shop, 20 in the erecting shop, and 11 in the tank and tender shop for reaming and tapping for stay-bolts. The advantage of being able to bring the tool to the work in place of taking the heavy work to the tools effects a considerable saving. Previous to the adoption of compressed air machinery in this plant this class of work was done entirely by hand. Considerable annoyance was at first experienced by the oil, necessarily used in large quantities, coming in contact with and softening the rubber hose used for supplying the air to the drills. After some experimenting, a hose covered with duck and treated with boiled linseed oil was adopted, resulting in quite a reduction in the cost of maintenance.

Three bolt-cutting devices are used for cutting off the projecting ends of boiler stay-bolts after they have been screwed into place. These have proved themselves not only labor-saving, but the results obtained are much more satisfactory than with the old method of chipping the ends off by hand, as the use of the hammer and the chisel was liable to loosen the bolts in the thread. This is entirely avoided by the improved process. The apparatus, when swung from a jib crane, can be easily managed and operated by one man, and will cut off the stay-bolts much more rapidly and neatly than by the old method.

Seven hammers for calking the seams if tender tanks are used in the tender shop in addition to a number of heavier hammers in the boiler shop for chipping purposes.

Pneumatic moulding machines in the foundry are used to mould small patterns which are symmetrical, and where a large number of pieces from the same pattern are required, such as brake heads, brake shoes, etc. The process is completed with great rapidity, and the capacity of the machine is limited only by the speed with which the operator removes the finished flakes and supplies fresh ones to be operated upon.—*Cassier's Magazine.*

Efficiency and Capacity Test of the Ingersoll-Sergeant Drill Co's Plant Installed for the Boston Transit Commission, Boston, Mass.

In the early months of this year (1902), the engineers of the Boston Transit Commission undertook an accurate investigation of the properties of the soil and the exact conditions which were to be met in excavating Sections "C" and "D" of the East Boston Spur of the Boston Subway. These two sections are to comprise that part of the subway which connects the submarine tunnel, now being driven from East Boston by the Boston Tunnel Construction Co., and the present subway at Scollay Square. After careful study, it was decided to drive Section "C," running from State and India streets, to Atlantic avenue, by means of a shield, similar in design to the one now being operated in Sections "A" and "B." The quality of the soil and the many large buildings to be passed, made it seem advantageous to excavate Section "D" by the slice or cut and cover method.

Most of the readers of this journal know that to make use of all the advantages obtainable in the operation of shield driving unless the ground through which the tunnel is being carried is of an extremely self-supporting character, it becomes necessary to employ compressed air to support the face and walls of the tunnel, and in many cases to prevent flooding if water is encountered. In the present instance the tunnel leads through a blue clay of a favorable character and while no serious difficulty was expected in the completion of this section, it was considered advisable to use compressed air.

Bids were asked to cover the complete compressor plant, the contract being awarded the middle of March to The Ingersoll-Sergeant Drill Co., for the institution of the following Figs. 1 and 2:

Two 20" & 18¼" & 12¼" x 24", Class "AC" "Straight Line" Steam Driven Air Compressors with compound air cylinders, each having a capacity of 800 cubic feet of free air per minute, which is compressed to 120 lbs. per square inch, this pressure supply being used for the necessary hoisting and winding engines.

Two 18" & 24¼" x 24" Class "A" "Straight Line" Low Pressure Air Com-

pressors, each with a capacity of 1,150 cubic feet of free air per minute, and capable of compressing to 40 lbs. per square inch. These machines are to furnish air to the tunnel at a pressure of from 15 to 25 lbs.

Two 54" x 12' Air Receivers and one 42" x 10' Air Receiver.

Besides these "straight line" compressors a battery of three 150 H. P. return tubular boilers, a 60" x 130' steel stack, the flue connection of which is fitted with a main damper operated by a lock automatic damper regulator, the uptakes being furnished with individual dampers, one 500 H. P. Berryman feed-water heater, two 6" x 4" x 6" duplex feed pumps, all of which are thoroughly by-passed, making it possible to remove any or all without shutting down. All the feed water piping is of brass and all the valves above 2" are of the gate pattern. All the air and steam piping is arranged so as to enable the cutting out of any boiler or compressor without effecting the operation of the plant.

A by-pass is also furnished between the high and low pressure air pipe lines which makes it possible to throw any or all of the compressors into either system in case of necessity.

The water from the air cylinder jacket is discharged into the boiler feed tank, the greater part of which is used in the boilers and the remainder may be used in mixing the concrete for the tunnel walls.

It might be interesting to state that this plant was erected within a time limit of ten (10) weeks from the awarding of the contract, there being a forfeit imposed of fifty dollars ($50.00) per day if this time was exceeded. To prevent any manipulation of figures, or speeding up of compressors, the bidders were required to guarantee an actual delivery of the required air capacity, stating the necessary steam consumption in pounds of water fed to the boiler to deliver this quantity of air at the required pressure.

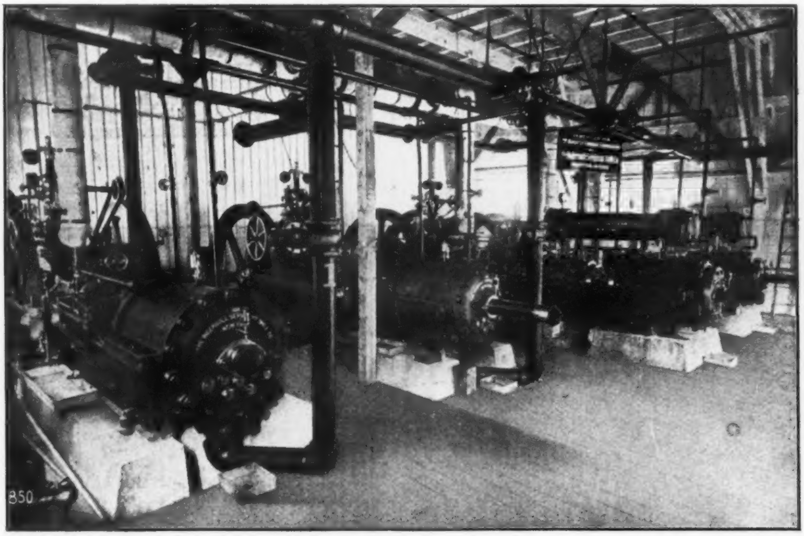


FIG. 1—COMPRESSOR PLANT, SECTION "C," BOSTON TRANSIT COMMISSION.

The terms which covered this guarantee and were embodied in the contract are as follows:

CAPACITY AND EFFICIENCY OF COMPRESSORS.

As soon as practicable after the plant is erected it shall be subjected to

"Efficiency test."

"Capacity test."

Each may be of about ten consecutive hours duration.

The "efficiency test" will be made on one of the low pressure compressors and one of the high pressure compressors. The choice of the compressors to be subjected to these tests will be made by the engineer.

The contractor hereby guarantees that each of the high pressure compressors will under the conditions of said test deliver 760 cubic feet of free air per minute compressed to 120 pounds per square inch and each of the low pressure compressors will under said conditions deliver 950 cubic feet of free air compressed to 40 pounds.

The actual number of pounds of water fed to boilers shall be determined by weighing.

In case the efficiency of the compressors in the said "efficiency test" falls short of that guaranteed by the contractor a fine shall be deducted from the contract price of the whole plant, to be calculated by the engineer from the following formula:

$$\text{Fine in dollars.}\left\{\left(\begin{array}{l}\text{Actual number of}\\ \text{pounds water fed}\\ \text{to boilers per hr.}\end{array} \times \frac{{}^{*}950}{\begin{array}{l}\text{Actual number of cubic}\\ \text{feet free air per min. delivered.}\end{array}}\right) - \begin{array}{l}\text{Guaranteed number of lbs.}\\ \text{water fed to boilers per hr.}\\ \text{while *950 cu. ft. of free}\\ \text{air per min. is being com-}\\ \text{pressed to 40 lbs. per sq. in.}\end{array}\right\} \times 12$$

FIG. 2—BOILERS FOR COMPRESSOR PLANT, SECTION "C," BOSTON TRANSIT COMMISSION.

The foregoing formula is for the pair of low pressure compressors. The formula for the pair of high pressure compressors is arrived at by substituting 760 in place of 950 and 120 in place of 40.

The total fines will be determined by the sum of the fines of the two efficiency tests.

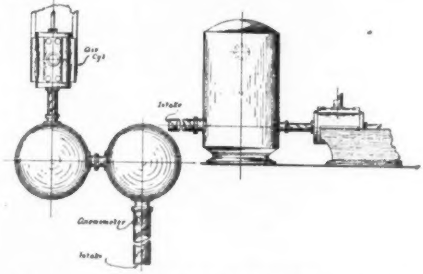


FIG. 3—ARRANGEMENT FOR TESTING COMPRESSOR CAPACITY.

The "capacity test" will be made on the boilers and compressors. All the compressors are to be run for about ten consecutive hours at one time, both the high pressure compressors at their maximum rated capacity (800 cubic feet of

FIG. 4—COMBINED AIR CARD HIGH-PRESSURE COMPRESSOR.

free air per minute against a pressure of 120 pounds per square inch) and both the low pressure compressors at the required capacity of 1,000 cubic feet of free air per minute against a pressure of 25 pounds per square inch, and the boilers must be of such capacity that they can easily supply the necessary amount of steam at 100 pounds pressure with the natural draught.

If the boilers provided are unequal to this the contractor shall without additional expense to the commission increase the capacity of the boiler plant until these requirements are easily met.

Each boiler feed pump shall be capable under easy running of supplying the boilers when all are being run at their maximum capacity.

The steam piping shall be so arranged as to be secure against leaking due to expansion and contraction.

All the main steam pipes shall be covered with a sectional covering of magnesia 1 inch thick.

The following is the method employed to correctly measure the quantity of air

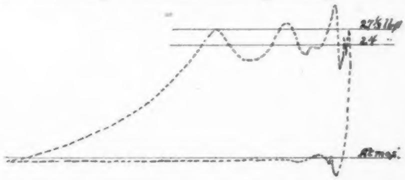


FIG. 5—AIR CARD LOW-PRESSURE CYLINDER.

without going to so great an expense for apparatus as to make a test prohibitive.

Referring to Fig. 3, the two 52" x 12' receivers furnished with the plant were connected together at their upper nozzles. To the lower nozzle of one was attached a galvanized iron tube leading to the air intake of the compressor, while to the lower nozzle of the remaining receiver was fastened a 12 ft. galvanized iron tube having a diameter of approximately 12". In this tube near its innermost end was placed an anemometer, which has previously been calibrated (by Professor Berry of the Boston Institute of Technology), by means of a standard nozzle under similar conditions of pulsation and velocity. This, of course, furnished a positive method of determining the quantity of air taken into the compressor, and what is most interesting, the results practically coincided in the high pressure test with the figures offered by the manufacturer, while the results from the test of the low pressure compressors were far in excess of the required cap-

acity, giving a very high volumetric efficiency, as shown in the following figures as officially taken by the Boston Transit Commission.

		Amount specified in contract.
Easterly high pressure engine.		
September 10th, 1902.		
Actual number of pounds of water fed to boilers per hour..............	4.767	4.800
Actual number of cubic feet free air delivered per minute at 120 lbs. receiver pressure.......	778.6	760
Easterly low pressure engine.		
September 11th, 1902.		
Actual number of pounds of water fed to boilers per hour	3.292	3.680
Actual number of cubic feet free air delivered per minute at 40 lbs. receiver pressure.......	1.021.1	950

As it will be seen from this report two separate tests were made, the one on Sept. 10th, lasting for four hours and being run on one high pressure compressor. 100 lbs. steam pressure was carried upon the boilers, the air being compressed to 120 lbs. in the receiver. Under these conditions the machine was run with a 5-16 cut-off and showed a steam consumption of approximately 25 lbs. of water per I. H. P. per hour with an air capacity of 92.7 per cent. of the piston displacement.

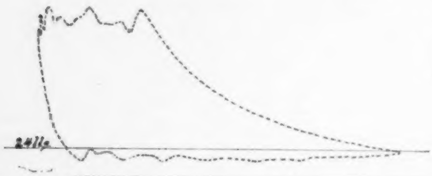


FIG. 6—AIR CARD HIGH-PRESSURE CYLINDER.

On the following day the test upon the low pressure machine, lasting four hours, showed a capacity of approximately 93 per cent. of the piston displacement with a steam consumption of approximately 26 lbs. per I. H. P. per hour, with a boiler pressure of 100 lbs. and a terminal air pressure of 40 lbs. in the receiver.

The steam consumption as given above was determined by weighing the fater fed to the boiler, no allowance being made for the steam required to operate the feed water pumps.

We also show cards obtained at the time

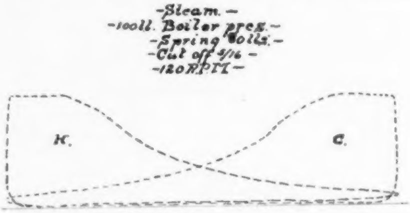


FIG. 7—STEAM CARDS LOW-PRESSURE COMPRESSOR.

of the test, Fig. 4 being a combined card for the air end of the high pressure compressor. Fig. 5 is a low pressure air card from the same compressor, while Fig. 6 is from the high pressure.

Fig. 7 is a double card from the steam end of the low pressure compressor, and Fig. 8 is an air card from the same machine.

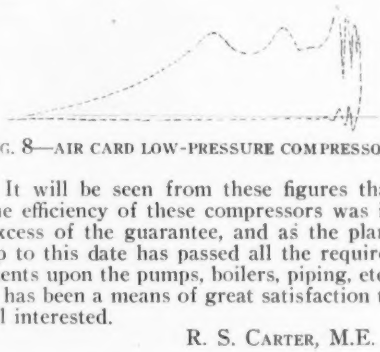


FIG. 8—AIR CARD LOW-PRESSURE COMPRESSOR.

It will be seen from these figures that the efficiency of these compressors was in excess of the guarantee, and as the plant up to this date has passed all the requirements upon the pumps, boilers, piping, etc., it has been a means of great satisfaction to all interested.

R. S. CARTER, M.E.

The North River Tunnels by the Sooysmith Freezing Process.

Mr. Charles Sooysmith has brought forward a plan for driving the Pennsylvania tunnels across the North River by the freezing process. In general it is proposed that the tube tunnels shall rest on a substantial pile foundation, and that they may be anchored to this foundation if there is any apprehension that the tunnels will float up or shift laterally. It is the opinion of

Mr. Sooysmith, however, that there need be no apprehension of displacement of the tunnels by reason of their comparative buoyancy. The material at the depth at which it is proposed to place the Pennsylvania tunnels is comparatively firm and compact, but probably it is not sufficiently so to resist the vibration of moving trains.

Among the various methods which have been brought forward is one for dredging a channel, driving piles in it, and then lowering the tunnel sections through the water; and another is to run the tunnel sections out by the use of a shield and the pneumatic process, occasionally sinking a pier as the tunnel proceeds. The plan proposed by Mr. Sooysmith avoids one of the great objections to the former of these two methods, namely, constant interference by river craft. On the other hand, it is believed that it will give a better result than the second method suggested in that the foundation will be continuous, and that the tunnel does not require the large amount of metal necessary to give it transverse strength as if it were to be carried from pier to pier—at once a tunnel and a bridge. The pneumatic shield method necessitates the use of a very heavy lining of cast iron, and some engineers consider that there is danger of rupture from the pounding of moving trains. Further, the tunnel can be driven through the frozen material exactly as a land tunnel is driven, by open headings, without compressed air and without trouble from water.

Outline Description of the Method.—The plan contemplates a foundation or anchorage of piles along the line of the tunnel. To get these piles down to the great depth desirable, a tube somewhat larger than the pile will be driven by water jet to about the level of the bottom of the tunnel. The pile is then telescoped through the tube, being driven by a Nasmyth hammer lowered down into the tube. This would be worked by compressed air. The hammer is enclosed in an air-tight shell which extends to below the top of the pile and the water is kept out by compressed air.

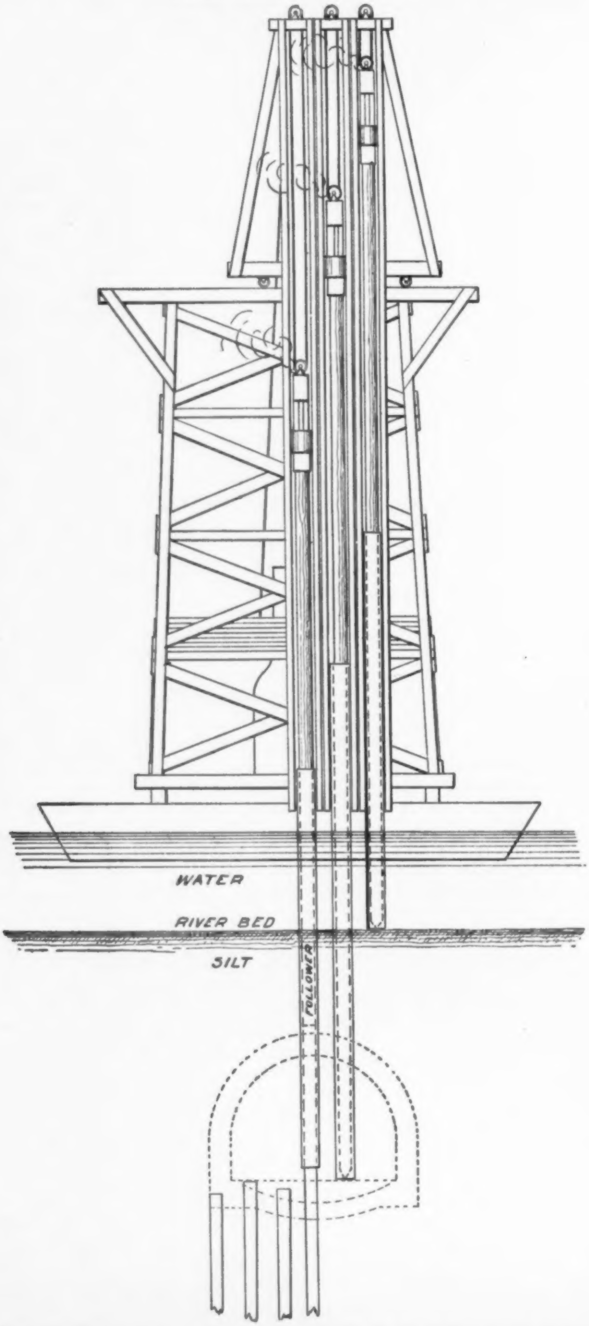
Over the piles along the center line of each tunnel will then be driven by compressed air a small pilot tunnel, 6 or 7 ft. in diameter. The pilot tunnel is to serve as a refrigeration chamber from which to freeze the material around and to such a distance outside of it that an excavation for the full size tunnel may be safely made within frozen material. The means for doing this will be those commonly employed in cold storage and ice-making plants. The rate of freezing, the distance out to which the freezing can be done, the strength of the frozen material, and all data necessary to establish the practicability and safety of this procedure have been obtained chiefly from work already done by the freezing method and from actual experiments with Hudson River silt made with this particular work in view.

Within the space excavated, as before described, the paramount tunnel structure will be built upon the piles, cut off at the required depth as the frozen material is excavated. Having provided a continuous rigid foundation and a clear space of the requisite dimensions any desired tunnel structure can be built.

Pile Driving.—Pile driving plants will be specially prepared for this work with adequate anchoring devices, and provision will be made for handling two or more piles without change of position of the supporting barge. The leads as a whole will be made adjustable on the barge so that more than one bent of piles can be driven without a relocation. The machinery of the barge will include pumps and special hoisting drums for raising the guide tubes.

A tube somewhat larger in diameter than the wooden piles to be used, being suspended in the leads and provided with suitable arrangements for application of water jets will be sunk so that its bottom will be at about the level of the bottom of the proposed tunnel structure. Experience shows that a tube can be thus sunk to a depth of 50 ft. in less than two minutes. The pile may be placed in the tube before it is sunk into the bottom; the follower or Nasmyth hammer will then be placed on the pile, and the latter driven home.

The steel tube will serve to attain an accurate location; as a means of overcoming the frictional resistance down to the point to which the top of the pile will be driven; and as a guide for the pile and driving devices. The tubes will not be withdrawn till they have served as locating guides for the next tubes and piles to be driven. The pile driving begins near the shore where operations will be easy, and it nowhere runs into conditions of excessive difficulty; into none, in fact, as troublesome as have in other localities been overcome by simple means.



PROPOSED METHOD OF DRIVING PILES IN THE HUDSON RIVER.

Refrigerating of Pilot Tunnels.—Assuming that two tunnels only are called for in the first construction, small tunnels 6 or 7 ft. in diameter will be driven, one on the center line of each proposed large tunnel. These small or pilot tunnels can be built at a rate of at least 10 ft. a day after work is well inaugurated, indeed at considerably greater speed. In the construction of the first 1,500 ft. or more of the Hudson River Tunnel, no shield was used, but the compressed air was counted upon to hold back the material at the heading some 22 ft. high. To hold the material back at the bottom there was a constant necessity to make the air pressure much greater than the hydrostatic pressure at the top of the tunnel. Then at intervals blow-outs occurred lowering the pressure and causing an inflow of material. These difficulties led to the employment of a shield for the work last done. Soon after starting the old Hudson River Tunnel, and up to the time of the employment of the shield, that is, throughout a distance of over 1,500 ft., a small tunnel called the "pilot" was driven in advance of the main heading, as a means for lessening the size of the main heading and for affording a centering for the bracing. The construction of this pilot tunnel gave no difficulty, but it was rapidly and cheaply built without the use of a shield. The small exposed face of the pilot tunnel made its construction easy and safe without the use of a shield, even when further progress with the main heading became difficult and costly. These statements are based upon the personal experience of Mr. Sooysmith, who was for months almost daily in the heading of the old Hudson River Tunnel.

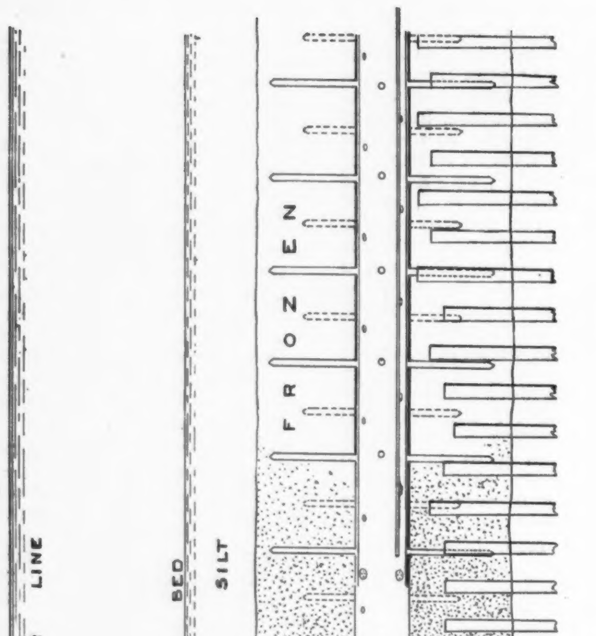
As fast as the pilot tunnels are advanced the necessary freezing pipes may be put in place and the circulation of the cold brine commenced—or if cold air is to be used it may be introduced at once. It may prove more advantageous to do the freezing and excavating at the same time, always keeping the excavation a safe distance from the limit of the frozen material.

In order to enable the freezing to be commenced before the completion of the pilot tunnels, it is proposed to build a third small tunnel simultaneously with the other two, to be used as a working tunnel, locating this on the center line of a prospective third large tunnel, or it may be between the first two large tunnels to be built, and in the future use be made of it for conduits or other purpose.

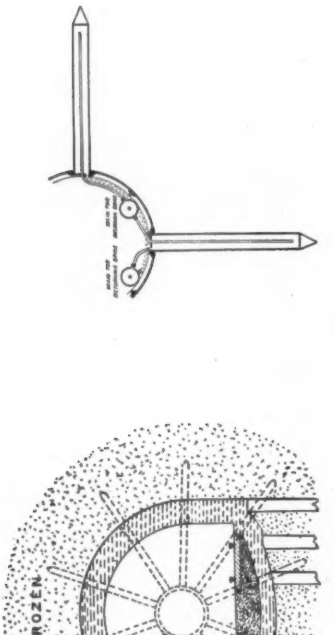
This third tunnel would serve as a working passage-way to the headings of the two refrigerating tunnels by means of connections between the three tunnels at intervals of a few hundred feet. For instance, after the three tunnels have been completed to a distance of say 500 ft. from the shaft, cross connections between them will be made and the two for refrigerating service will be put into use for this purpose. At a further distance of say 500 ft. another crossover will be made and then 500 ft. more of two of the tunnels can be put into use for freezing. In connection with the location of the refrigeration plants, it may be mentioned that brine is now being circulated for refrigerating purposes a distance of at least half a mile from the machinery.

Ice Machines.—With a compression machine, a brine temperature of — 20 deg. F. can be easily maintained, and the absorption machine works economically at still lower temperatures. There are great numbers of both kinds of machines in use, and their employment for the object in view will differ in no manner from uses to which they are now put. The ice machine used at Iron Mountain, Mich., froze at the start two cubic yards of saturated earth per day per ton of refrigerating capacity. Later, when the abstraction of the heat had to be through a long distance of frozen material, the efficiency was reduced to half this amount, or one cubic yard per day per ton capacity. Assuming that the entire distance from shore to shore for two tunnels is 10,000 ft. of tunnel, and it is desired to freeze it in 365 days and, providing for a frozen wall at least 5 ft. outside of the line of excavation, there will be 287,400 cu. yds., or 787 cu. yds. per day to be frozen. This, assuming the average efficiency between the maximum and minimum rates of freezing for Iron Mountain above-mentioned, will call for a total refrigerating capacity of 525 tons, or 1½ cu. yds. per ton per day. One of the advantages of the freezing method is that a serious breakdown of the machinery, even could it disable the entire plant for several days, will not cause a disaster to the work.

Pipes for Circulation and Freezing.—In the work at Iron Mountain the freezing was done by circulating the brine



MR. SOOYSMITH'S METHOD OF UNDER-WATER TUNNELING BY FREEZING.

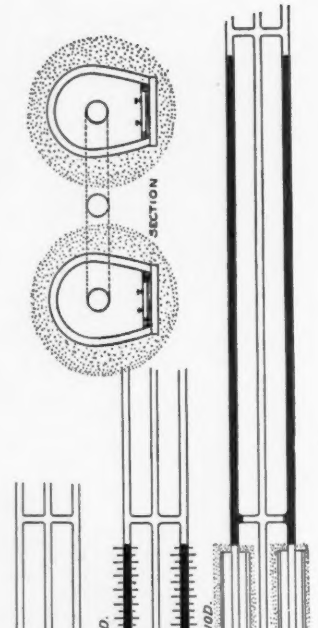


MR. SOOYSMITH'S METHOD OF UNDER-WATER TUNNELING BY FREEZING.

through pipes 8 in. in diameter. At the end of 72 days the material was frozen for a distance of 9 ft. from the circle of pipes. It is probable that in a tunnel construction, particularly where material not easy to penetrate with pipes is encountered, the freezing would be done by the circulation of cold air or brine through the pilot tunnel or through pipes laid in the same. In the case of a double track tunnel where it might be impracticable or take too long to freeze the requisite distance, the excavation might begin when the frozen wall outside the pilot was 5 or 6 ft. thick. Two or three feet of this would be excavated outward from the pilot, and in this way by successive annular cuts let the excavation follow the freezing, instead of waiting until the entire mass is frozen. In case the work is done in the same way as for shaft work, radial pipes will be pushed out in sections at intervals from the pilot. They will extend three or more feet beyond the limit of the space to be excavated, and their number and location will be such as to give the same absorption area per cubic yard to be frozen as was provided by the pipes at the Iron Mountain work.

This provision will leave no question as to securing a continuous frozen mass to at least 5 feet outside of the space to be excavated, and this within a period less than 60 days; this too, on the supposition that the circulated brine will be at a temperature not lower than—10 deg. F.; the ice machine used will be capable of producing a much lower temperature. In each of the pipes and to nearly its outer end will extend a pipe 1 inch in diam., and the systems of large pipes and small pipes will be connected together in such a way that the brine will be constantly circulating through the large pipes.

In order that temperature observations may be made, small test pipes will be put out at short intervals, these test pipes extending 10 feet beyond the space to be excavated. The temperature observations which will be constantly made will afford information at all times as to the progress and extent of the freezing. Owing to the uniformity of the material under the Hudson, this freezing will be uniform with uniform circulation and temperature of brine. With the system proposed, it will be possible to freeze most rapidly and make the wall thickest at the points of greatest pressure, or at



Progress Sheet—Plan and Section.

UNDER-WATER TUNNELING BY FREEZING.

points where any recesses in the tunnel structure (should any be desired) or any enlargements of the structure itself may call for an enlargement of the excavation.

Strength of the Frozen Material.—The frozen wall will be of a material very compact and perfectly saturated, though, owing to the pressure which it is under having only enough water to fill the voids (about 30 per cent.). This condition gives the maximum strength for a frozen mass. Its temperature will be considerably below the freezing point, which adds much to its strength and prevents it from thawing as the excavation proceeds, even though the excavated chamber were warmed. The excavated chamber will remain for weeks at a temperature much below the freezing point unless artificially warmed, and the thickness of the frozen wall will continue to increase for many days after the circulation through the pipes has been discontinued. This is because the temperature in the frozen mass will have been lowered materially below the freezing point; in other words it will act as an exceedingly cold body still absorbing heat. An illustration of this may be noted in the behavior of the earth in some parts of Siberia and of Alaska, where the earth is perpetually frozen to many hundred feet in depth. Tests show the compressive strength of frozen silt from the bottom of the Hudson River to be from 400 to 600 lbs. per square inch.

Excavation.—Frozen silt or quicksand has about the appearance of sandstone, and a good deal of its character. Under low temperature it is very tough. It may be drilled and blasted without effect on the mass of material a short distance from the charge fired. It can be picked or chipped by hand at a speed that would be permissable for the work in question, but one of the two following methods will be employed for its excavation.

Sections of the pilot tunnel and the circulating pipes will be successively removed a few feet in advance of the excavation. The circulating pipes when emptied of brine will be warmed by a circulation of steam or otherwise for a moment or so till they are loosened and can be withdrawn. The holes so left in the frozen mass will serve as a means of breaking off into the heading large masses of the frozen material. This will be done by power wedges specially designed for the purpose, or by lime cartridges.

Or it may be found preferable to use a chipping machine run by electricity or compressed air, to chop the material from the heading. Should speed require it, the excavation may be done in two or more offsets or the entire heading may be kept in a conical shape to afford large working surface. As the piles are encountered in the excavation, they will be sawed off or dressed, as called for by the plans.

Summary.—It is claimed that while no tunnel has ever been built on the plan proposed it involves only processes, the success of which has been fully established by work already done. The plan described provides:

1. A method of driving piles, the success of which, in the light of work done in many places by means of water jet and steam hammer pile driver, cannot be questioned.

2. The construction of small tunnels in the Hudson River, the practicability of which has been established by the pilot tunnel in the old Hudson River work, and by numerous small tunnels through soft material under the lakes, and other places.

3. The solidification of the material about these pilot tunnels by the common methods widely in use for refrigeration and ice-making, and the application of which to the freezing of the material in the bed of the Hudson offers no problems or difficulty the solution of which has not been demonstrated by the work done by Mr. Sooysmith at Iron Mountain, Mich. The rate at which this material can be frozen, and its strength and capacity to sustain surrounding pressure when the tunnel space has been hollowed out, were demonstrated by the conditions existing at Iron Mountain by the tests made there, and more particularly by the strength of material taken from the bed of the Hudson River, frozen and tested by Prof. Denton. By the test pipes at frequent intervals the extent of the frozen wall will at all times be known, and it is claimed that the method outlined is freer from possibility of accident and unexpected delay than any other plan yet suggested, including the various schemes of building in sections and lowering from above.

The projected tunnels of the Pennsylvania Railroad and the Rapid Transit Co. under the East River will pass through much more difficult materials to excavate than the uniform silt of the Hudson. The

formation consists of peaks of rock and pockets of mud, gravel, sand, quicksand and clay, and it will be very difficult to maintain air pressure in a shield. These difficulties are much less in the building of a small pilot tunnel for freezing purposes. Inasmuch as the rocky material contains little water, the freezing process there will progress rapidly.

One of the merits of this plan is that a double-track tunnel can be readily and cheaply built, or single-track tunnels easily connected. And it is specifically claimed that tunnels can be built in this manner cheaper and quicker than by any other possible method.—*Railroad Gazette.*

American Manufacture of Ping Pong Balls.

A correspondent writes to the editor of the *American Machinist* as follows:

"You have recently published an article, entitled "British Triumph," referring to the making of ping pong balls, which was taken from the *London Graphic.* The said article was quite sarcastic, claiming a victory for the British, and saying that the Americans could make almost everything except a ping pong ball. In the same issue the *American Machinist* said that there was about one hundred patents issued in the United States on golf balls, and suggested that by the time there were a hundred patents on ping pong balls the American ball might be as good as the English.

Up to the present only one American inventor has challenged the British in making ping pong balls. From the picture, Fig. 1, it may be seen that the first man who began to file patents is already embossing 220 half-balls in one operation in less than two minutes' time, while the English are embossing their balls one by one. According to this, 60,000 half-shells are embossed every ten hours. That means a daily output of 30,000 balls through one press alone.

This is not the best we can do as yet, so says Mr. John Whitehouse, the inventor of this process. At the time he started to make ping pong balls he had made himself acquainted with every conceivable means for stretching celluloid, which indeed is a very peculiar material. The male and female die is the first thing a person will think of, but owing to the fact that celluloid will not draw into a die like any metal will, but, on the contrary, that it has to be held firmly and the embossment stretched out of the thickness of the material, naturally, if a sheet of celluloid is taken, say, 1-100 inch thick, and a half-shell of a ping pong ball is embossed of the same, if it cannot draw in (as it will not) through the stretching the celluloid will take a variety of thicknesses. The bottom of the half-shell in the die will be much thinner than its sides. Owing to this fact it is very expensive to make a male and female die that will have the proper clearance according to the stretch of the material. It has been found that a metal female die and a male die made of paper work quite satisfactorily, by reason of the elasticity of the latter, if both are heated to about steam temperature.

This is the method shown in the half-tone picture. An entire sheet of celluloid is taken and placed in the machine and 220 half-shells are the result per operation. This is over one hundred times as fast in making ping pong embossments as that of our English friends. Yet this American inventor is anything but satisfied by being one hundred times as fast as the English. He says that soon he will have metal male and female dies, and he will then be able to produce these goods ever so much faster, for the reason that metal will heat ever so much faster than paper will, as after each operation both the male and the female die have to be cooled while under pressure, or otherwise the hot celluloid would shrink out of shape. The reason that it does take two minutes to make one embossment of 220 half-shells is because paper is a non-conductor of heat, and for that reason is slow in heating and cooling.

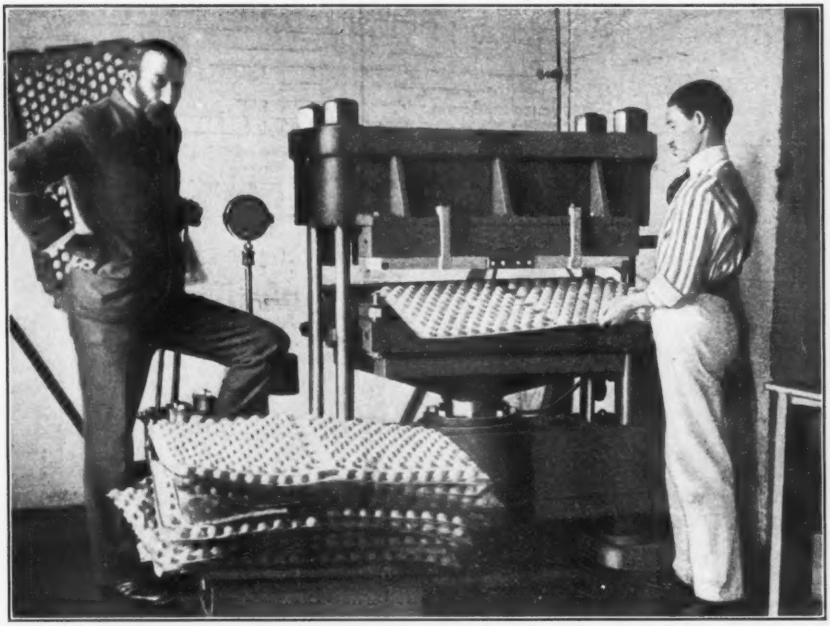
The only thing left to do, says Mr. Whitehouse, was to devise some means through which a metal male and female die could be made in an inexpensive way, which he says is as follows. He makes his cast-iron female die as usual and secures a sheet of flexible rubber equal in thickness to that of the celluloid to be embossed over the die, which then is placed in an electrolytic copper bath. The tank which contains the copper solution has a cover which is closed, and an air pressure of 50 pounds per square inch is produced therein. The solution under pressure will force and stretch the rubber

into the female die and keep the rubber there until a deposition of copper of about ⅛ inch in thickness takes place. As rubber will stretch exactly the same as celluloid does when heated, the above mentioned necessary clearance according to the stretch of the material is hereby secured, and the method of embossing as the result is much faster than with the male and the female die when the former is made of paper.

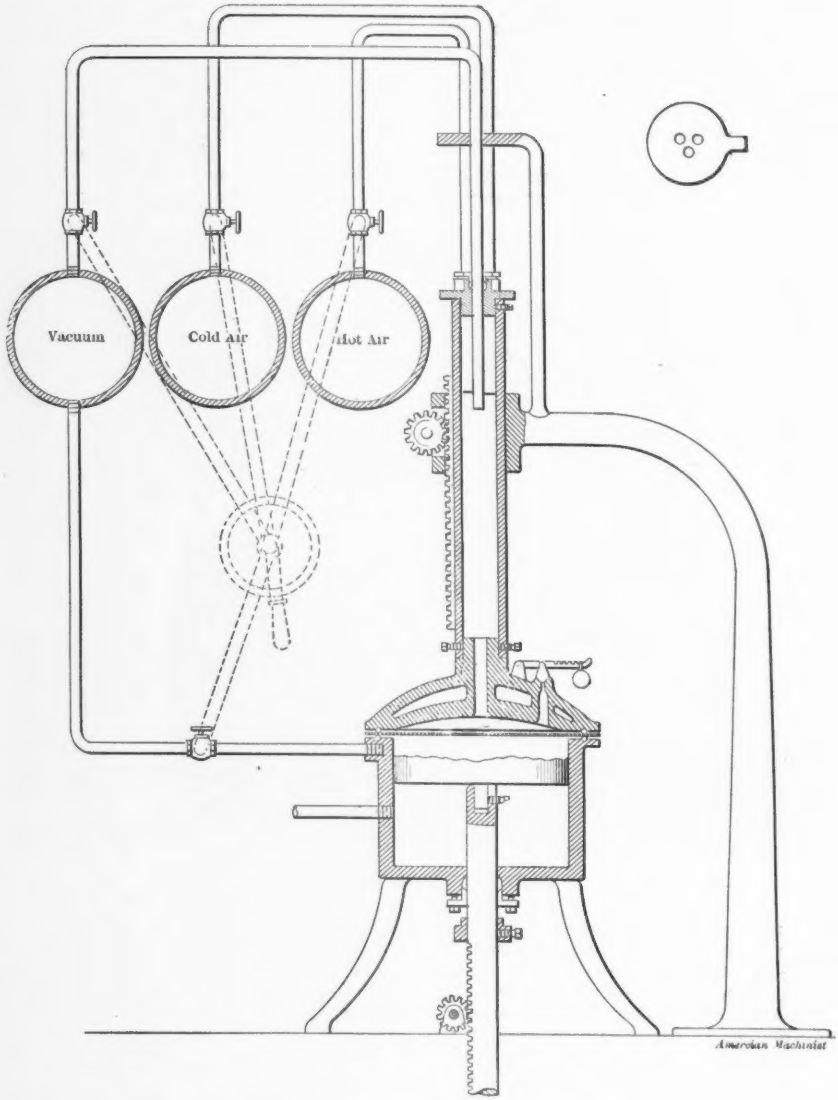
The inventor is not fully satisfied with the result obtainable from a metal male and female die. In a short time he will build a large machine through which he will be able to emboss as many as 250,000 half-shells per day. When embossing an entire sheet of celluloid in one operation quite a number of difficulties have to be overcome. If a sheet of celluloid is placed over a die so that the air is enclosed in each of the cavities and becomes hermetically sealed therein with the celluloid, it is quite hard to get rid of the same.

The accompanying outline sketch, Fig. 2, of the air machine shows how it will operate. The celluloid is held in a frame by its edges and becomes a diaphragm, and as such it is placed over the die and is held on a packing ring. The female die is vertically movable and is lowered away from the diaphragm of celluloid to be embossed. The air is exhausted from the female die and it is then brought back to its original position to be in contact with the celluloid. In this way a partial vacuum takes place in the die. The upper half of the machine is brought down on the celluloid and through a packing ring it is hermetically sealed on its outer edge. It is now ready to be embossed. Compressed air at a temperature of about 220 degrees Fahr. and with a pressure of 100 pounds per square inch is admitted. The celluloid through the heat and pressure instantly stretches into all the cavities, no mater how deep.

It is claimed that with this method celluloid of only 1-100 inch thick can be embossed to a depth of from 5 to 7 inches. The peculiarity of celluloid is that if the same is not cooled under pres-



EMBOSSING PING PONG BALLS.



CELLULOID EMBOSSING PROCESS.

sure while in the die it will shrink considerably. To this end, while the pressure is kept up by the compressed air the same is rapidly cooled through a circulating stream of cold air or water. The whole operation takes place in about 30 seconds. The vacuum pump almost instantly produces the vacuum in the female die. The hot compressed air (which is connected to the male die) almost instantly performs the embossment. The jet of cold water (or cold air) quickly performs the cooliing. After all this the finished embossment is taken out and replaced with a new sheet to be embossed.

This machine will not only make ping pong balls at an enormous speed, but it will emboss designs and figures of every kind, and the most beautiful work in the line of embossments can be readily performed on this machine at a very low price. Considering that celluloid always retains its high polish, no matter how deeply embossed, the most intricate work with the sharpest of corners and the minutest of detail can be performed, even if there should be undercuts on the picture or design.

This is only the beginning of the products of one inventor who has started in to challenge the British. He is not satisfied with being able to turn out 100,000 ping pong balls daily with one machine. How about the other ninety-nine inventors?

JOSEPH MISKO.

A New Type of Air Compressor.

This machine represents the latest product in this exacting field and is designed to meet the growing demand for higher efficiency in air compression, that naturally attends the steadily increasing adoption of pneumatic machinery in all branches of industry. It is known as the Class C. S. C. pattern, designed for a delivery air pressure of 100 lbs. per square inch, with a steam pressure of 100 to 150 lbs. The compressor illustrated has low pressure steam cylinder 31 in. diameter, high pressure steam cylinder 20 in diameter, low pressure air cylinder 28 in. diameter and high pressure air cylinder 16½ in. diameter, all cylinders being 24 in. stroke.

The capacity of the compressor is 1,710 cubic feet of free air per minute when operated at 100 revolutions, or 2,052 cubic feet at 120 revolutions.

In design, the frames follow the most approved Corliss construction and are of exceptional strength, to withstand extreme strains without producing mechanical distress. The steam and air cylinders are tied tandem to each other with heavy tie rods and are rigidly supported by a sole plate, which extends beneath all four cylinders. The pillow blocks have extra broad pedestals and all frames are planned perfectly true on the bottom, assuring a perfect alignment.

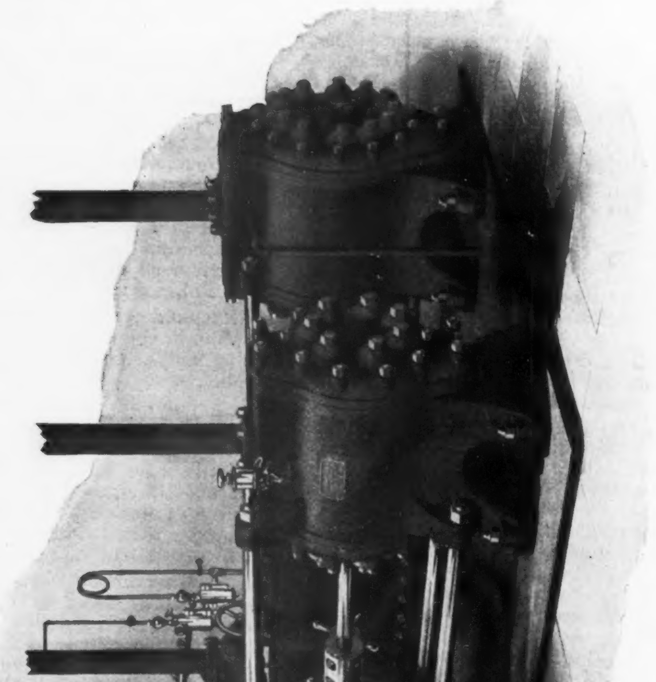
All cylinders are of extra close grain iron, with appropriate thickness for reboring, and are bored absolutely true and parallel.

Steam and air pistons are of solid type, cored hollow to avoid unnecessary weight, and are provided with snap rings of special iron carefully fitted to place. They have no followers or bolts, thus avoiding liability of accident. Stuffing boxes are of ample depth. Piston rods are of steel, turned true and polished.

The air cylinders and cylinder heads are thoroughly water jacketed. Provision is made for a circulation of cold water the entire length of the cylinder, the water passing also through the heads, its cooling effect being especially concentrated around the discharge valves, which naturally sustain all of the heat due to compression and friction that has not been eliminated by the water jacket during the actual process of compression.

A novel feature, the value of which as a safeguard cannot be over-estimated, is an outside water connection for conducting the circulation of water between air cylinder and cylinder head, excluding the possibility of serious accident through water entering the interior of cylinder should the gasket between cylinder and head become ineffective.

The bearings are exceptionally large and well proportioned. The main bearings are provided with removable shell boxes and only the best phosphor bronze and genuine babbitt metal are used. All bearings are adjustable for wear, with ample provision for oiling. Steam valves are balanced slide valves, adjusted to realize the highest attainable ecenomy in the consumption of steam and are provided with Meyer independent adjustable cut-



CROSS COMPOUND STEAM-DRIVEN AIR COMPRESSOR, CHICAGO PNEUMATIC TOOL CO.

off. All valves have provision for readjustment when required by wear.

The air inlet and discharge valves are of the poppet type, placed in the cylinder heads from the outside and immediately accessible for adjustment or repair without removing the cylinder heads. The valve, valve stem and head are forged in one piece, entirely avoiding the use of flange nuts, jam nuts, split pins or other contrivances intended to serve as a head for the stem, needing constant supervision, with continual liability to work loose. A feature of more than ordinary importance embodied in this valve is the fact that the valve seat is a part entirely separate from the cylinder proper and may be removed, replaced or renewed whenever occasion requires. In most forms of air compressors employing poppet valves, the valve seat forms an integral part of the cylinder head, affording no opportunity for renewal when it becomes worn. The valve and seat form a complete piece of mechanism which may be examined, re-ground and adjusted separate from the compressor.

The valve seats are of bronze and the springs of steel, light enough to minimize resistance in opening, yet strong enough to promptly seat the valve in closing. The proportion of valve area to cylinder area is exceptionally liberal, enabling the cylinder to fill freely at each stroke, without volumetric loss or impaired efficiency due to the wire-drawing effect of insufficient valve area.

The cylinder flanges are recessed to effectually prevent the valves from falling into the cylinders, avoiding the necessity of a guard plate and the consequent clearance loss resulting from its use.

The cranks are of disc pattern, made from best quality charcoal iron. Shafts and crank pins are forced to their places, the former being keyed and the latter riveted, especial care being exerted to have the shaft and pins absolutely parallel. Crank pins are of special ground steel. Crank shafts are of unusual strength, made from best hammered machinery steel, accurately turned and finished.

Connecting rods are made from best forged steel, carefully finished. Boxes are adjustable for wear, and accord with the most approved practice in all classes of compressors.

The guides are bored and crossheads are provided with babbitted shoes at the top and bottom with wedge adjustment for taking up wear.

A combined speed and pressure regulating governor is provided, having a connection to the air receiver, and regulates the steam supply to the compressor to suit the air consumption, maintaining a constant unvaried air pressure, even though the demand be intermittent. Working in combination with this governor is a speed governor for regulating the speed of the engine.

The inter-cooler furnished with this type of compressor consists of a set of tubes encircled by a steel shell, into the heads of which the tubes are fitted, suitable provision being made for expansion and contraction. A constant circulation of cold water is maintained through the tubes, and the compressed air from the initial compressing cylinder enters the inter-cooler on one side and after thorough distribution and contact with the tubes discharges from the other side, passing to the next compressing stage. Adequate provision is made for readily cleaning the interior of the inter-cooler, and the tubes, being of composition metal, do not rust or become foul.

In many forms of compound compressors the advantages to be derived from two-stage compression are not realized because of inadequate cooling surface in the inter-cooler, or because the air comes in contact with the cooling surfaces but once in passing through the inter-cooler.

Complete provision is made for automatic oiling, sight feed lubricators of ample capacity being furnished for steam and air cylinders, centrifugal oilers for crank pin bearings, and oil cups of approved pattern for all wearing parts.

Steam and air cylinders have indicator connections, and indicator diagrams are taken under the exact working conditions.

This type of compressor is manufactured by the Chicago Pneumatic Tool Co., and is built in three sizes ranging in capacity from 500 to 2,000 cubic feet of free air per minute and is also built with simple steam cylinders, for plants where the available steam pressure does not warrant compounding. Single and Duplex Compressors in a variety of sizes are also manufactured.

A Pressure System of Pneumatic Tubes.

A pressure system of pneumatic tubes, that is, tubes operated by the expanding force of compressed air, is the only system founded upon good mechanics.

As the compressed air is let out from the generating plant it can be introduced into a tube to make the transmission of a carrier, and then be shut off as soon as the transmission has been effected; but where the air is drawn towards the operating machinery, as in tubes on the suction principle, the power cannot be shut off, and the current has to be maintained constantly through the tubes when carriers are not being transmitted. Such use of power is in obvious great waste, as average tubes are only used to the extent of a small fraction of their possible use.

In a vacuum like the suction system there is no reserve of power, and hence stoppages of carriers in the tubes occur, and make it necessary to take the tubes apart to remove the carriers. And further, in suction tubes, as the current can travel only in one direction, two lines of tubing are required between each two points of communication.

The advantages of a compressed air system are:

I. Economy in the Cost of Maintenance.—An air pump and a storage tank for air pressure generate and maintain the power for operating the tubes.

The air pressure is carried by ordinary iron piping to the terminals of the tubes.

The tubes are normally open to the atmosphere. When a carrier is to be transmitted the air pressure is introduced into the tube which draws off some of the supply from the storage tank.

An automatic regulator, which controls the starting and stopping of the pump, is operated by the rise and fall of air pressure in the storage tank. The pump stops when it has produced the normal pressure of the system. It automatically starts into action when air is drawn off to make the transmission of a carrier. There is accordingly no waste of power. In an average system of tubes a saving of upwards of sixty per cent. is made.

II. Reliability in Operation.—There can be no stoppages of carrier in a tube, making it necessary to take the tube apart to remove it.

There is an abundant reserve of power to force the carrier through the tube.

The air supply pipe is smaller in area than the tube, and consequently while the carrier runs freely through the tube the air pressure from the supply pipe becomes expanded in the tube to a lighter degree of pressure. Hence if a carrier tends to foul in a bend or other part of the tube it forms a resistance, and the air pressure behind it instantly makes up to the full degree of the pipe pressure, and so the carrier is automatically relieved and pushed along. Beyond this, by adjusting the regulator, the pressure in the system can be raised many pounds, to the full capacity of the pump, and this high pressure can be used to free the tube in case the necessity arises from accident or misuse.

III. Single Tubes can be Used Between Two Points of Communication.—As the air pressure is admitted into the end of the tube to make the transmission of the carrier, it can also be admitted into the other end of the same tube, and carriers can therefore be dispatched alternately from either end of the same tube to the other end. As an average transmission is made in a few seconds' time no practical inconvenience is experienced by using one tube for transmissions in opposite directions. The use of single tubes saves room in the passageways and walls of a building, which is often a point of considerable importance.

The question may be asked, What [illegible] prevent carriers from being dispatched from both ends of a tube at the same time? This does not happen, because when a carrier starts from one end, the atmospheric air in the tube immediately rushes out of the other end, and a carrier cannot be inserted until the first carrier arrives, which is a matter of only a few seconds' time.

Double tubes can be used between each two points, but the additional tube is entirely unnecessary, as has been proven in the widest application and in the most exacting service. Why pay for more brass than is required? Why fill passageways and walls with useless piping?

IV. Automatic Dispatching Terminals.—The important element of the compressed air system is the dispatching terminal at the end of the tube.

Great improvements have been made in the form of terminals. A gate or cover, being normally open, is closed, shutting off the tube from the atmosphere, when a

carrier has been inserted for transmission. The act of closing the cover automatically opens an air valve which controls the supply of compressed air.

Recent inventions have produced a very simple device for shutting off the air pressure automatically when the carrier has completed its transmission. The gate or cover becomes locked in its closed position, and the automatic device is adapted to unlock the cover at the proper time, permitting it to return to its normal open position, and permitting the air valve to close, shutting off the air pressure. This tripping device is made a part of the dispatching terminal, and is operated by the air pressure where it is located without the use of any other agent, or of mechanism running between the two ends of the tube. These new terminals embrace principles of the utmost importance. They are essential to a first-class system.

You would not equip a building with electric lights to burn everywhere all the time, in order to have light in occasional dark hours. Why keep a blower continually running on the suction principle to maintain a constant current of air through pneumatic tubes for occasionally dispatching a carrier?—*Power and Transmission.*

The Locke Electric Rock Drill.

This is the invention of H. B. Locke, a mining engineer of thirty years' experience who considers it the long-sought for perfect electric drill. It uses no flexible shaft, but the motor is attached to the drill mechanism by means of a telescope shaft, which travels the whole length of the hollow motor shaft. The motor is a ¾-H. P., 220 volts direct current, and is both dust and water proof. It makes 2,500 revolutions per minute, and runs in ball bearings, so that the drill can work at any angle.

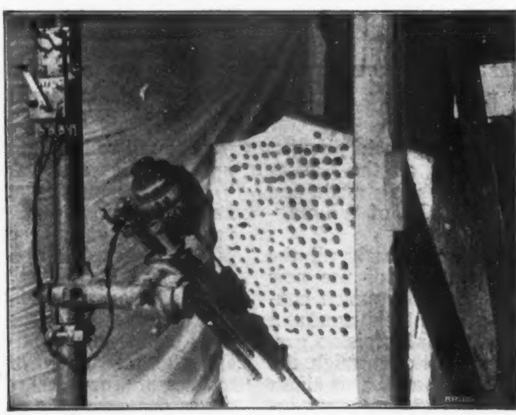
The feed of the drill is 18 inches, and the steel used is ⅞-inch octagon, or 1-inch star steel. The size of the bit is 2 or 2¼ inches, according to the desired depth of holes.

The drill can be handled by two men as the total weight, including motor, is 239 pounds, but one man can separate it into three parts in less than one minute, when the parts will weigh as follows: Motor, 95 pounds; drill, 91 pounds; base, 53 pounds.

The drill makes 360 blows per minute and the spring which actuates the piston is 720 pounds. In other words the power that pushes the piston forward is 720 pounds, which gives a great velocity to the piston and drill. The rate of drilling is about one inch per thousand blows in the Platte canon granite.

The machine is a ball-bearing one, and the strong spring is compressed by rolling a large steel ball around a helical cam; the release of the spring strikes the blow.

Mr. Locke informs us that one of these drills has been run for four months at the factory of the American Bicycle Company



THE LOCKE ELECTRIC ROCK DRILL.

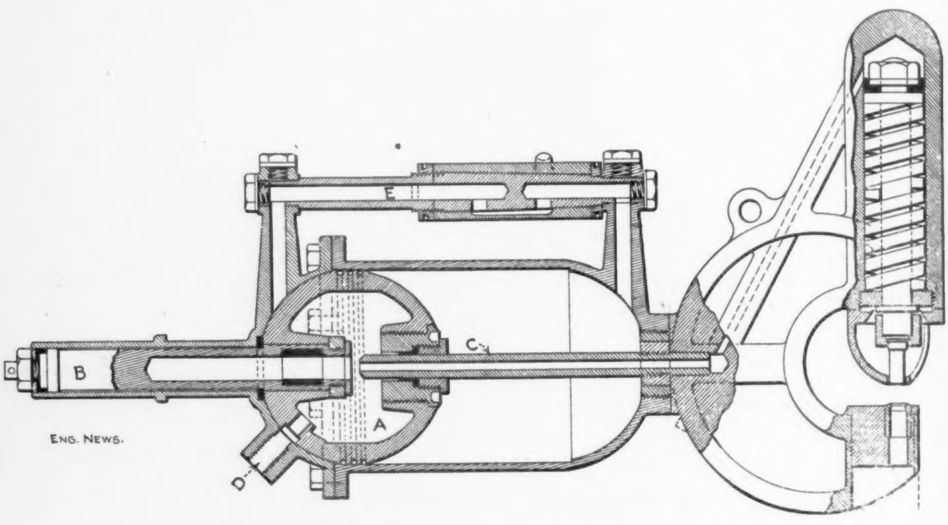
at Hartford, Connecticut, where the drills are made, without showing any wear or breakage.—*Mining Reporter.*

A Punch Operated by Combined Air and Hydraulic Pressure.

We illustrate in the accompanying cut a sheet metal punch whose construction and mode of operation present distinctly novel features. Briefly described, it is a portable puch operated by air and hydraulic pressure coacting by means of a special mechanism to drive a punch plunger. The new tool is known as the Caskey pneumatic punch and is being made and sold by F. F. Slocomb & Co., of Wilmington, Del.

The illustrattion shows clearly all the essential structural features of the new punch. As will be seen, the punch consists of a cylinder in which works a spherical hollow piston. This piston carries a tail rod which works through the rear end of the cylinder, and, also slides in a stationary hollow rod extending inward from the cylinder head. This stationary hollow rod connects with a passage leading to the cylinder of the punch plunger. The piston and its hollow tail rod, the stationary hollow rod, and the passages leading to the punch plunger cylinder are kept filled with oil. The pressure of this contained oil in the punch plunger piston, when the air cylinder piston is actuated by air pressure, operates the punch. The working of the several parts described to bring about this action are as follows:

Referring to the illustration which is a longitudinal sectional elevation of the punch, A, is the hollow ball piston carrying the tail rod or intensifier, B, and sliding on the stationary hollow rod, C. When the piston is at the rear point of its stroke the end of the rod, C, is approximately at its center. To drive the piston forward air is admitted to the cylinder at D. At an early period in the forward movement of the piston the rod, C, telescopes into the tail rod, B, and seals communication between its cavity and the interior of the piston. As the movement forward of the piston continues the entire air pressure behind it is concentrated upon the columns of oil



DETAILS OF PORTABLE PUNCH OPERATED BY COMBINED AIR AND HYDRAULIC PRESSURE.
F. F. SLOCOMB & CO., WILMINGTON, DEL., BUILDERS.

contained in the rod, C, and the passage leading to the punch ram chamber. When the piston has completed its working stroke a hand valve is turned in the by-pass, E. This admits the air to the other end of the cylinder and equalizes the air pressure on the two sides of the piston, but the area of the rod, C, being less than that of the tail rod, B, a greater force is exerted on the forward face of the piston than on the rear face, and it is driven back into position for another forward stroke. The punch plunger is meanwhile returned to a similar position by the coiled spring.

From the preceding description of the operation of the punch it will be seen that one cylinder full of air accomplishes both the forward and the return stroke of the piston. Further, the volume of oil in the piston, its rods and the connecting passageways being just sufficient to depress the punch a certain distance, as soon as the hole is punched no further downward motion of the punch is possible, and all jarring and undue strain is prevented. The makers point out further, that owing to the peculiar construction and arrangement of the ball piston and the parts coacting with it, it is impossible for any air to get into the high pressure passages, unless the oil level in the piston is permitted to fall below the top of the opening in the tail rod, when the piston must be refilled at once.

The punch described is made in a number of sizes for plate work, and is also made with a special auxiliary stroke attachment for work on structural shapes or wherever it is necessary to clear any projection. The "auxiliary stroke" is actuated directly by air pressure admitted to the auxiliary piston chamber, and may be given any travel desired, but after clearing the projection the punch is operated as described above. The punch is portable, and can be operated by one man. —*Engineering News.*

A Compound Air Compressor.

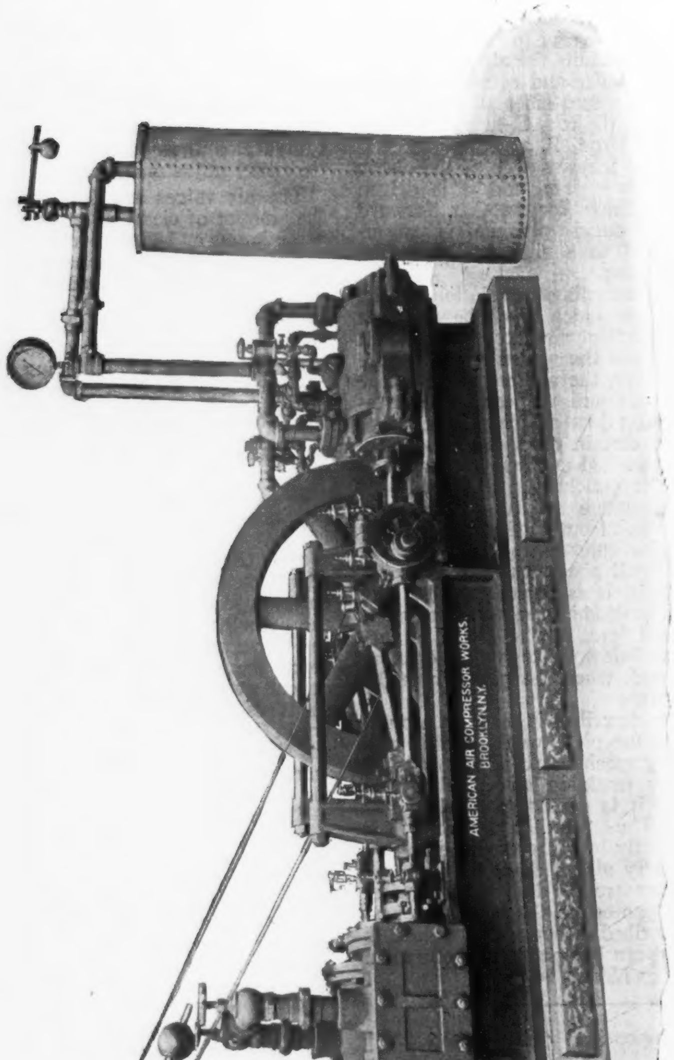
A new type of compound (two-stage) air or gas compressor is being manufactured by the American Air Compressor Works, of Cortlandt St., New York. The demand for compressors of this kind has become so large that the leading manufacturers are devoting much attention to this class of machine. The American compressors as will be seen from the halftone, are simple and compact in design and it is intended that every working part shall be readily accessible. The makers have discarded useless coverings and complicated devices as far as possible with a view to having any engineer of ordinary caliber capable of making the necessary adjustments, etc.

The air valves are designed to reduce the amount of clarance in the cylinders to a minimum and the valves instead of being located in the top or bottom of the cylinder shell are placed in the heads. The valves are made of the best phosphor bronze and aluminum and the man in charge can at once inspect the inlet and discharge valves by removing the cylinder covers. This is considered preferable to having the valves located at different parts of the cylinder, in which case each one must be removed and inspected separately.

With the valves placed in the head, as previously described, there is an opportunity for a complete circulation of water around the entire shell of the cylinder, an advantage which is put into practice. The company does not, however, water jacket the cylinder heads because it complicates the valve arrangement and in the second place there has not seemed to be any urgent requirement for this addition to the present design. The suction valves are in the bottom of the cylinder head and are therefore away from any heated surface and the air is thus permitted to enter the cylinders at a normal temperature.

The intercooler is open at the top and consists of a plain tank and a series of coils. It is so arranged that it can be disconnected from the compressor and the latter may be thus operated without injury. The builders point out that in some types of air compressor the intercooler is placed underneath the machine, in some cases forming part of the bedplate, and in such instances it would be necessary to remove the compressor from the foundation should a break or other defect occur in the intercooler and require inspection.

The steam cylinders have been carefully designed to attain high economy in steam consumption and the workmanship and materials—in fact the compressor as a whole—is guaranteed against any defect. The American Air Compressor Works manufacture these machines for pressures

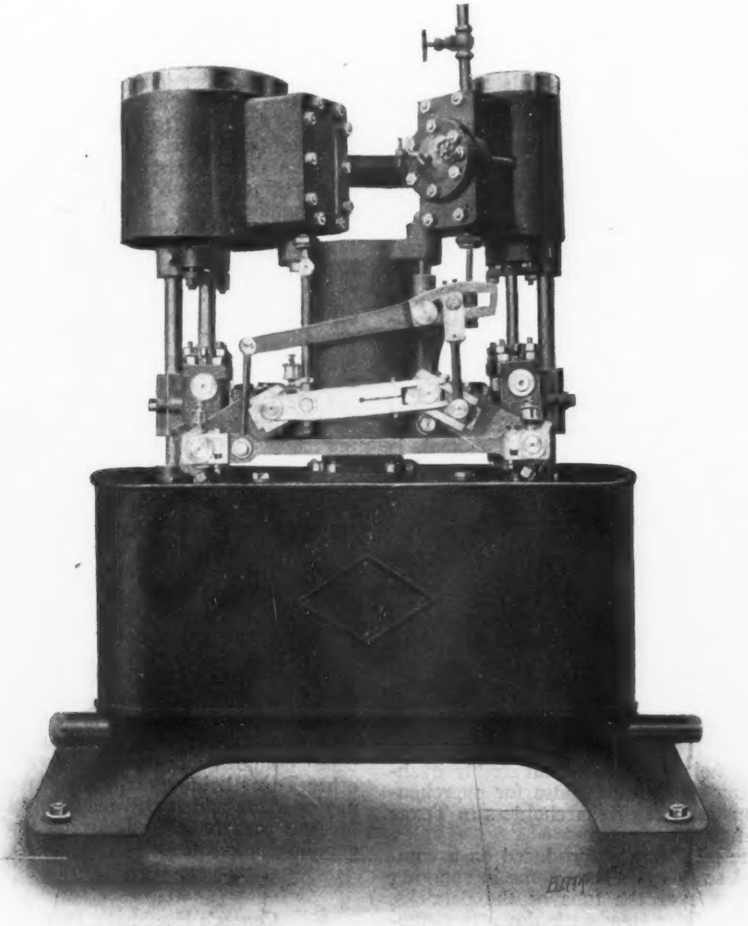


THE AMERICAN AIR COMPRESSOR WORKS' NEW COMPOUND MACHINE.

from 80 up to 500 pounds, according to the individual requirements. The machines are built for the higher air pressures with compound air cylinders and the different machines are also made to operate by belt or other gearing as desired by the purchaser.—*Iron Trade Review.*

The Heisler Air Compressor.

The steam end of this compressor is of the same general construction as that used in the Heisler pumps. The air end consisting of two air cylinders of usual construction with the usual form of



THE HEISLER AIR COMPRESSOR.

poppet inlet and discharge valve. The cylinders are submerged in a tank, which can be readily removed. This tank has a large volume of water around the cylinders, preventing clogging of cores about the cylinder, and gives a much larger percentage of cooling surface.

The entire cooler is of cylindrical form, arranged vertically and centrally in the machine, it forming part of the support for the steam cylinders which are separated from it by use of non-conductors. The compensating mechanism is mounted upon this inter-cooler; the steam cylinders have a volume ratio of approximately 6 to 1, the high pressure cylinder usually cuts off at nearly half stroke, giving about 12 steam expansions. This pair of engines has given an I. H. P. (when made cross compound) on 30 lbs. of steam per hour, running non-condensing with 112 lbs. steam pressure. When running triple expansion it has given an I. H. P. on 26 lbs. of steam per hour, which we think is remarkable when considering that the engine is of such small size, having steam cylinders 7½ and 16 inch bore and 10 inches stroke. The air cylinders are 7 and 14 inches bore.

In the larger machines Corliss inlet valves are sometimes used. The tank is also made in sections so a portion of it can be readily removed.

The Pumping Stage at Beaumont.

Most of the big producing wells on Spindle Top Heights, Beaumont, Texas, are either being agitated by compressed air or pumped, or preparations are being made to install pumps. A number of the wells, but not many, will gush when uncapped. New wells which come in on the famous heights are still invariably gushers. But there is no cause for apprehension on the part of shareholders in Texas oil companies.

Since oil was first produced on a commercial scale wells have come in spouting oil, often over the tops of the derricks. Sooner or later they settle down to pumpers. Some of them, notably upon the Fox farm near Foxburg, Pa., have continued for years to pump as much oil as when first struck. In time every great well in the Baku region of Russia becomes a pumper, but it produces thousands of barrels of oil daily. Baku is to-day producing more oil than it ever did.

Gas is almost invariably struck with oil. As long as the gas pressure lasts the well spouts oil. When it ceases the well has to be agitated with compressed air. That is precisely what is being done by oil producers of the Beaumont district today. Beaumont can only be likened to Baku. Never have such great oil producers been struck in the world's history as at Baku and Beaumont. The oils of both regions are heavy and closely resemble each other in every respect. They seem to come from the same strata and are probably due to the same period of the world's formation.

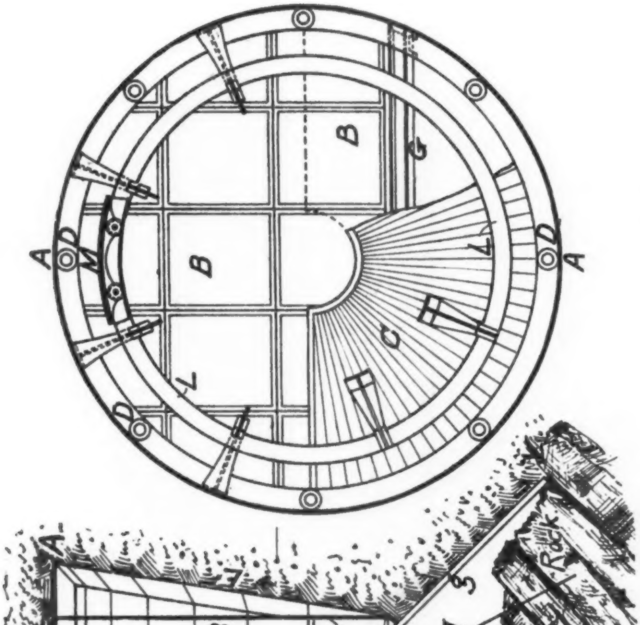
When the gushers of Spindle Top were all spouting oil only last winter contracts were made for its sale as low as 3 cents per barrel, and some companies could not sell their oil at any price. It is now selling at 20 cents at the well and 30 cents on board cars at Gladys City. Experienced oil refiners, carriers and selling companies agree that Texas oil will probably be selling for 50 cents per barrel on January 1 next.

Experience in agitating the Beaumont wells with compressed air and by pumping shows that it is only a question of the capacity of the machinery to force the oil to the surface as to what the wells will produce. Some of the companies are introducing pumps that will lift 10,000 barrels of oil to the surface each day from one well. As everybody knows, the lakes of oil are there, and each well fitted with machinery necessary to do the work is turning out more money each day than when it was a so-called gusher.

Taking the history of the Baku fields on which to base an estimate the wells in Texas will be producing a generation or two from now at least, and before that time doubtless every company having other Texas holdings will have brought in new gushers which will inevitably in time become compressed air wells and then pumping propositions.—*National Reporter.*

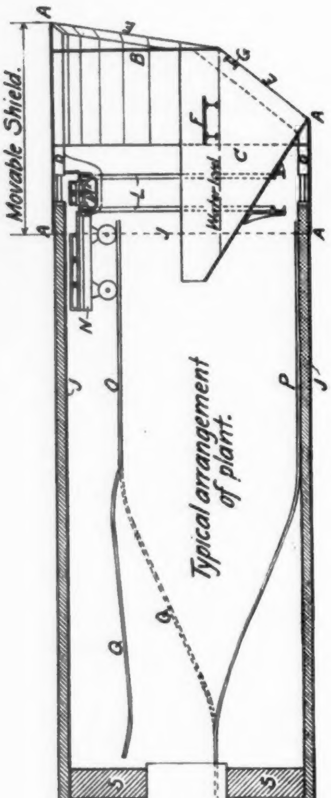
Cooper's Pneumatic Shield.

Mr. Theodore Cooper, of New York, has just patented a pneumatic shield for driving tunnels and sewers in water-bearing materials, which is shown in the



PART OF COOPER'S PNEUMATIC SHIELD.

(See next page for descriptive matter.)



PART OF COOPER'S PNEUMATIC SHIELD.

A—External shell.
B—Partial forward hydraulic bulkhead fitted with the usual traps and exploration openings.
C—Sloping and tapering after hydraulic bulkhead.
D—The operating and adjusting rams.
E—The cutting edge, the lower part cut back to expose the material of the bottom and the upper part given any desired slope.
F—The working platform.
G—Removable beam for holding the poling bars g.
H—An emergency door, if desired.
J—Tunnel with completed lining.
K—Car for excavated material.
L—Circular tram for segment carried M.
N—Segment delivery car on upper track O.
P—Lower track for material car.
Q—Vertical switch.
R—Air lock in compressed air bulkhead S.
—Railroad Gazette.

engravings. The purposes of the various parts are clearly indicated by the table.

It will be observed that the fundamental fact underlying this device is the use of a water seal in the bottom of the shield. The water is allowed to enter in the taper and sloping bulk-head placed back of the usual bulk-head, and this water is, of course, balanced by the air pressure in the shield. It will be at once apparent that this water seal will simplify the matter of driving through material of varying character. As the shield penetraets very loose material the air is still held by the water seal and the necessity does not arise for covering the bed of the river with clay to prevent the blowing out of the air, as has been done at great expense in some recent operations. This again permits the tunnel to be driven closer to the bed of the river, thus lightning the grades of the approaches. Engineers who have driven shields underneath rivers will remember occasions when it would have been a great comfort to them to feel sure that the air could be held.

It will be noticed that this tapering after bulk-head permits the placing of the permanent lining rings close up to the front of the work.

The special merits of this shield are summed up by Mr. Cooper, as follows: While maintaining the balanced water level, it gives ready access for excavating and the use of excavators for silt, sand or gravel; it allows drilling, blasting and removal of boulders and rock ledges; it permits the sinking of piles under the bottom as the work progresses; soft material may be forced by the rams to flow directly into the material cars; it delivers the materials inside of the lined portion of the tunnel without interference with the placing of the tunnel lining, so that both operations can be carried on at the same time; it materially reduces the time and cost of construction; it needs no earth cover to prevent air blowing out.

The reader will, of course, understand that the drawings do not pretend to show those details which are common to all shields of this sort, but special attention is called to the device for delivering the segments of the lining rings and for putting them in place.—*Railroad Gazette.*

The D'Auria Air Compressor.

A correspondent writes to the editor of *American Machinist*:

"I have long been ambitious to invent an air compressor, something new and wonderful and, like a certain water wheel once tested at the Holyoke flume, having an efficiency of 115 per cent. (Fact, this statement was made in the makers' catalogue. I cannot swear to the exact percentage, but it was considerably over 100.)

"In searching for similar devices already on the market which I might conflict with when my ambitions should be realized, I came across the D'Auria compressor, described on page 661, Vol. 24, by Mr. Morris. (A description of this compressor has also appeared in COMPRESSED AIR June, 1901.) It is decidedly the most remarkable machine I found in my search, and I would like to find out how its most remarkable feature impressed some of your other readers. Generally, when anything of this sort comes out, they are inclined to discuss its merits, but in looking over my files I cannot find that the D'Auria compressor was even touched upon.

"It is certainly a machine of exceptionally handsome design, one which doesn't give a fellow a feeling that he would like to whittle it down in some places and tack on it in others, but where every part seems to be just about right for what it has to do. This is a quality that makes any piece of machinery look handsome to mechanical eyes, and without it no machine is likely to be more successful than that Gothic bird cage typewriter whose frame was designed by a celebrated architect or World's Fair fame.

"While I cannot pick any flaws in the general design of the D'Auria compressor, I am wondering if the fundamental principle on which it is based, the "hydraulic compensator," is really much more of an improvement to an air compressor than a Gothic frame is to a typewriter. Mr. Morris certainly gives some pretty convincing statements as to its smooth running, but as he does not give the address of the makers and I have not been able to get a copy of their catalogue and study into the matter I shall have to admit I see no reason why a given weight of moving water confined in tubs should

have any greater effect on smoothness of running and general efficiency than an equal weight of iron, perhaps in the form of a flywheel, moving at the same velocity. The cuts show the area of the compensator piston to be four times the sectional area of the water passage, which increases the speed of the water column to that amount and gives it a corresponding leverage on the piston when it is helping the latter out on the last part of its stroke. At 340 strokes per minute, the speed at which it was running when Mr. Morris was able to balance a 5-cent piece on edge upon it, although it was not bolted to the floor, I should look for considerable water friction in those curved passages.

"Mr. Morris tells us that in the larger compound machines, weighing 46,000 pounds, the work done is equal to that of a crank-and-flywheel compressor whose flywheel alone would weigh 45,000 pounds. If my assumption as to the relative efficiency of the water column and flywheel is correct, this size of the D'Auria compressor must be handling 45,000 pounds of water, or some over 5,000 gallons, so I must be off the track somewhere.

If there is any particular advantage in the reciprocating motion of the water column over the rotary motion of the flywheel, certainly a reciprocating counterbalance of iron can be easily arranged, and if it were connected to the piston rod by a 4:1 lever connection, why would it not have precisely the same action as the column of water? I should expect it to have considerably less working friction than the water column with its extra piston and rings and, by shortening the length of the machine, make it stronger for a given weight of frame.

"If this reciprocating counterbalance, of either water or iron, is the correct thing, why have none of our locomotive designers given it a trial? I have always understood that it was the excess of counterbalance in the drivers over what was needed for the connections alone that made an engine pound hollows in t' track at high speeds and ride with a motion comparable to that of a "racking" horse. If the D'Auria theory is correct, the weight of the connections only should be counterbalanced in the drivers and that of the cross-head, piston, etc., might be taken care of by a 'hydraulic compensator' or some other form of reciprocating counterbalance.

"The elimination of this faulty counterbalancing was one of the principal points claimed for the Heilmann electric locomotive, a machine which generated its own current as it went along from a dynamo driven by a high-speed engine with two cylinders placed, if my memory is correct, crosswise of the frame. Perhaps by the time anything of this sort gets a chance for a practical test the steam turbine will have relieved us of all our trials in connection with counterbalancing reciprocating motion as far as engines are concerned, but in the line of air compressors there doesn't seem to be much to show in rotary machines, at least for pressures above what is needed to blow a furnace or a church organ.

"Most of the compressors used in this section are of the belt-driven type, and, in spite of their two heavy flywheels, they are very hard on driving belts. There is no question about finding a good market for such a machine as I spoke of at the beginning of my letter, even if the efficiency does fall a trifle below 115 per cent."

E. R. Plaisted.

[The reason why the weight of the water in the compensator of the D'Auria compressor is so much less than the weight required in the flywheel of the usual type of machine is, as we understand it, that the motion of the water is stopped at the end of each stroke. In other words, the entire stored energy of the water is available for completing each stroke of the machine, whereas with a flywheel only that portion of the en(which is represented by the comparatively small loss of velocity which is permissible in passing the center is available for that purpose. We do not know whether the weight of the water is considered as part of the weight of the machine or not. As as operative machine it is part of it, but it costs nothing and does not have to be transported, neither of which can be said of a flywheel. Considered as a machine to be bought, shipped and paid for, the water is not part of it. We believe that Prof. D'Auria did considerable work on the idea of a reciprocating mass of iron before arriving at the hydraulic compensator. We are not acquainted with all the reasons which led to the device finally adopted, but perusal of the article referred to will show that the water compensator possesses a valuable safety feature which

the mass of iron does not. The compensator piston has a number of slots so arranged that in case the piston, for any reason, should over-run its intended length of stroke, a by-pass will be opened and the compensator piston will be relieved of the pressure due to the moving water. The smoothness of running is due to the fact that in one leg of the water passage the water moves in one direction, while in the other leg it moves in the opposite direction, the combined inertia displacement effect of the water being *nil*. The reciprocating parts tend to displace the machine, but they are light and, moreover, the law of acceleration and retardation is more favorable than in crank machines. In the latter the acceleration and retardation are at a maximum at the end of the stroke where the speed is at the minimum, whereas with the D'Auria machine they are more nearly constant, and hence have a less value than the maximum of the crank machine. The machine was made by the I. P. Morris Company, of Philadelphia.—ED.]

The Homestake Hoist and Plant.

The Ellison hoist of the Homestake Company, in the Black Hills, South Dakota, has been in commission long enough to get limbered up, its bearings polished and adjusted and to show its power, endurance and capacity for the generations of work before it in hoisting rock from the Homestake mines.

The hoist of the Anaconda copper mine of Butte, Mont., is a duplicate of the Ellison, and these are the two most powerful mine hoists known, with the possible exception of the great hoist of the Calumet & Hecla copper mine of Michigan, which raises ore from a shaft more than one mile in depth. It may be truthfully stated that the Ellison hoist has no peer on a gold mine in this hemisphere, if in the world. The Comstock lode in its prime of production set the pace for gigantic mining operations of the past in pumping and hoisting machinery, operating for a depth of 3,500 feet, yet it had no such monster of mechanical strength and power and skill in construction, as the Ellison hoist.

The present building, housing the machinery of the Ellison equipment, is 350 feet long by 100 feet in width, 80 feet in height, over the central portion, and yet a large annex to be constructed. The hoist engine was built by the Union iron works of San Francisco, Cal.—the same shops that turned out the great warship Oregon. It has two steam cylinders 30 by 72 inches and two steel reels 16 feet in diameter, which wind and pay out a flat steel cable seven inches wide by a full inch in thickness. The two cables at present are 1,500 feet in length each, with the intention of splicing an additional 1,500 feet to each when necessary as depth is acquired.

The hoist engine is partitioned off from the big building with a glass front toward the shaft. In this compartment are placed two small air compressor engines, auxiliaries for handling and governing the movements of the great machine. The clutches, post brakes, disc brakes and reverse gear are operated by compressed air and are entirely controlled by a set of three levers and one pedal, conveniently placed on an elevated platform from which the engineer has a full view of all the machinery and the shaft. The engineer touches a button, as it were, in answer to signals from the depths of the mine, and the vast complex machinery moves at his bidding.

The gallows frames are of a special design, consisting of steel beams and braces covering a large quadrangle on the rock foundation, giving firmness and stability to the pillow blocks.

The shaft has three compartments, in two of which are operated a double deck cage. Each cage carries four cars. When ore is supplied sufficient to keep the hoist moving, eight tons of ore are raised to the surface every two minutes from the 800 level; three top men dump the cars, feeding the ore to four No. 6 Gates crushers and return the empties to the cage. This is equivalent to 5,700 tons in 24 hours. The crushers occupy a space across the west end of the building about 50 feet from the shaft, and are placed below the floor sufficient to alllow good dumpage for the cars. The crushed ore drops down into underground bins of 3,000 tons' capacity. The tramway on the floor of the tunnel leading to these bins is 65 feet below the floor of the hoist. A steel viaduct is laid across Gold run with railroad track connecting these ore bins with the mills across the gulch. The ore train passes into the tunnel, loads from the crusher bins, delivers its load to the

mills, returns in 20 minutes for the round trip and delivery of 40 tons of ore—equal to 2,880 tons in 24 hours—capable, however, of being increased to the capacity of the hoist.

The boiler capacity furnishing the steam power for the hoist consists of eight Scotch marine boilers with a total capacity of 1,600 horse power. These boilers were made in the shops of W. J. Solberg & Son, of La Crosse, Wis.

In another compartment of the building are placed the crusher engine and an air compressor. This machinery was manufactured by Frazer & Chalmers, and consists of a cross compound Corliss engine of 265 horse power, driving the four large rock crushers. The air compressor is a three-stage high-pressure machine for furnishing the power for driving the air motor of the ore train, capable of increasing the pressure to 90 pounds per square inch.

An excavation is made in the rock below the floor of the hoist, 35 by 75 feet, for installing one of the largest air compressors heretofore built by the Ingersoll-Sergeant Drill Company. It will have a capacity for operating 125 machine drills. The power of this mammoth compressor will be furnished by a battery of eight boilers of 200 horse power each, which will occupy an annex to the hoist building. The Hometake company has two large air compressors installed—one at the Old Abe and one at the Highland hoist—from which a system of pipes radiate throughout the mines for conveying the power for running the rock drills convenient to points of usage. The power has been drawn upon heavily by the addition of many drills, thereby reducing the pressure below the maximum. The re-enforcement of 1,600 horse power will bring the pressure up to a high point of efficiency.

One is impressed with the solidity of the machinery, construction and all appointments of this stupendous equipment of mechanical skill, and marvels at the rapid yet easy and noiseless movements of the ponderous machines. The Ellison hoist, with viaduct, ore bins, tramway and all accessories, represents, approximately, a total cost in construction of $1,000,000. It was made possible as a vast economic auxiliary to mining and moving stupendous quantities of gold bearing rock known only on the great belt of the Black Hills. *—Lead Daily Call.*

The Hydraulic Air Compressor at Norwich, Conn.

In *Engineering News* we find an interesting letter addressed to the editor and the latters replay, which COMPRESSED AIR has taken the liberty of reprinting as follows:

Sir: It is to be regretted that Mr. Knight, in his article on "The Hydraulic Air Compressor at Norwich, Conn." (*Eng. News*, June 12, 1902), should have given so little account of the details of the essential feature of the apparatus, viz.: the compressor. For example:

(1) No dimensions of the air or separating tank are given.

(2) The position of the safety pipe is not shown; there is no indication as to how much the lower end of this pipe is above the lower end of the downflow pipe; nor is its diameter given. To be told that these last are "such as to prevent the water being forced below the bottom of the downflow pipe" does not convey any clear idea for lack of other data.

(3) What is the head-piece? Fig. 4 of the article does not tell. It is a part of the downflow pipe? Apparently not, because we are told that it "is situated vertically over the top of the downflow." If not a part of the downflow pipe, how far is it vertically above the latter? And how is it connected therewith?

(4) "The head-piece consists of a large number of tubes." . . . How many are there, and what is their diameter?

(5) "Means are provided for operating the head-piece for securing the proper immersion of the tubes and for regulating the amount of water passing through the head-piece." While it is not difficult to imagine means by which to do all this, it would be none the less interesting to know the means adopted in this special case.

(6) How is the outflow arranged after the water has passed out under the sides of the compression chamber? Is the outflow near the bottom or at some point further up not shown in Fig. 4?

(7) What pressure is obtained in the air main at the compressor, and what at the point of distribution? In other words, what is the loss of head in the four miles of main?

F. A. MAHAN,

51 Avenue Montaigne, Paris, France, Aug. 2, 1902.

(We give space to the above letter, because it illustrates very well the information which contributions to such a professional journal as *Engineering News* ought to contain, and in the second place, it illustrates the difficulties under which editors and contributors often labor in securing such information.

The reason why more detailed information concerning the apparatus was not given in the article as published was that the company preferred to have no further details concerning it made public.—ED.) *—Engineering News.*

Re-heating.

The editor of the *American Engineer and Railroad Journal,* referring to the article on the "Economy Derived from Reheating Compressed Air," which was published in the above-named paper and in the November issue of COMPRESSED AIR, says:

"It is generally understood that a saving results from reheating compressed air before its use in motors, but the figures given by Messrs. Edmondson and Walker indicate that the real importance of reheating is not appreciated. If it were, the principle would be more generally employed by the larger users of compressed air.

"The experiments described show a maximum gain, by reheating, of 44 per cent. in the amount of air required to produce a given amount of power, and that a compressor which is able to supply 100 H. P. at the motors with cold air may be able to supply 178 H. P. by the use of reheaters. This means that many compressors, which are now overloaded and are running too fast, may be made more effective, and the day of replacement by larger machines put off, by installing reheaters. A reduction of 30 to 40 per cent. in cost of production of compressed air by reheating it from 60 to 400 deg. F., just before using is thoroughly worth while, especially when the simplicity of the reheating is considered.

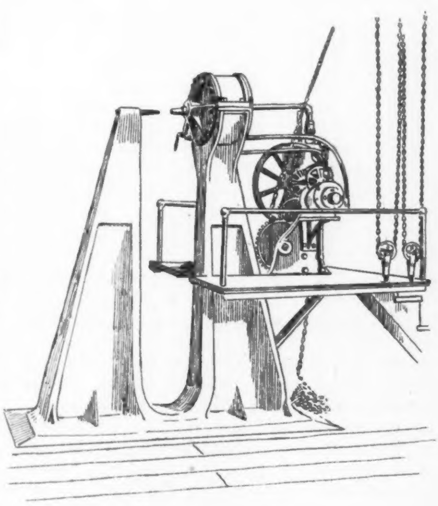
The contractors constructing the new Rapid Transit Subway in New York, who are using compressed air very extensively, appreciate reheating and employ it very effectively. On one of the sections, where reheaters are used, the heaters are of cast iron, made all in one piece cored out, in the form of stoves with small grates for the fires. These are placed near the air drills and are left out of doors and unprotected. The expense of the fire and its attendance is insignificant in consideration of the great gain in power.

The above-mentioned paper is presented in a way to give the results at a glance to busy readers. The comparisons are presented in curves, in which not only the figures of comparison are given, but also the probable limits to the practical economy of reheating are indicated. The heater used was capable of producing much higher temperatures of air delivered, but about 450 deg. seemed to be the highest temperature for satisfactory use in the small engine employed. It is important to notice that the speed of the engine increased with reheating of the air, also that the engine ran more smoothly and the cut-off was shortened. That is to say, the increase of volume of the air is not by any means the only saving due to reheating. The action is somewhat similar to that of superheating for a steam engine. There is, of course, no freezing of the exhaust with reheated air.

Plants may be installed at reduced cost throughout and the economy of operation is increased permanently by using reheaters. This is most effectively stated by the authors when they point to the fact that the results obtained by applying heat in this manner to compressed air are from 8 to 18 times more important than would be the same amount of heat expended under the boiler which drives the compressor.

Pneumatic Tools.

Here is a ten foot reach riveting machine, which also includes a radial crane with a pneumatic reversible hoist capable of lifting a load of 10 tons in either



FIXED PNEUMATIC RIVETER.

direction very readily. This machine is claimed to be one of the most simple and easily handled on the market. The tonnage can be instantly changed at the will of the operator, to suit light or heavy work; and having a cylinder designed with two separate compartments, each containing a 26 inch piston head, both secured to one piston rod, the closing of one compartment reduces the tonnage one-half; using both heads gives 50 tons on rivet dies, at a working pressure of 100 lbs., 40 tons being sufficient for all classes of ordinary boiler work; but the simplicity of this machine lays in the fact that it dispenses with high-pressure accumulators and pumps; requires no discharge pipes, hydraulic pipe, or expensive high-pressure valves, and the penumatic machine can be used in any climate, winter or summer, either indoors or out, without danger of freezing; and last, but not least, it is always ready for work, and there is nothing to get out of order.

PORTABLE PNEUMATIC RIVETER.

And also a 73 inch riveter especially designed for water and oil tanks, gasometers, stand pipes, ship and bridge work, having a gap of 12 inches; and unlike other machines, where the power is applied through toggle connections, there is no trouble in adjusting the dies to suit the many thicknesses of plate to be riveted, but has the required 50 tons pressure on the rivet dies at any point of the stroke, which is 3 inches. The machine is hung from a gravity point by a bail, and can be operated in any position to suit the work. The main frame of this machine is made of cast steel.

This riveter weighs 2,000 lbs., and exerts 30 tons pressure on the rivet dies at 100 lbs. pressure.

Both machines are built by the Baird Portable Machine Co., of Topeka, Kansas.

An Improved Hose Coupling.

Many dollars are annually wasted by leakage in compressed air lines. This waste is principally at the points where connections are made with the main line rather than in the main line itself. The accompanying illustration shows a hose connection, which has been designed to obviate these losses, especially when working under heavy pressures. The "G. E." hose coupling, as it is called by the makers, holds the hose securely compressed in a metal pocket, without the use of outside clamps.

Another feature claimed for this coupling is the increased size of the air passage, which is larger in the G. E. coupling than is possible in the old style couplings, where the hose is drawn over the corrugated end of the coupling. This coupling is suited for working under very heavy pressure. The ordinary coupling, although it fastens the hose to the coupling with clamps, will not prevent leakage at the end of the hose. In the G. E. coupling, the end of the hose is in a metal pocket and leakage is impossible.

As will be seen from the illustrations the coupling is of substantial proportions, and designed to give long wear. It consists of four parts, and is entirely self-contained, not requiring the additional purchase of hose clamps, nor involving the expense of their renewal.

Other advantages claimed for the G. E. hose coupling besides those above mentioned include its efficiency when working under heavy pressures. The first couplings made were tested to 700 pounds pressure without leaking. Its substantial propositions and the absence of projecting bolts secure a longer life than is possible with the old style couplings using outside clamps.

In the G. E. coupling, the hose is firmly secured by the pressure of the tapered portion of part 3, the latter being screwed into part 4 by means of the square socket at the larger end. There are several

THE G. E. HOSE COUPLING.

slight depressions in the walls of part 4, into which the pliable hose imbeds itself, making it impossible to withdraw the hose until uncoupled. A rubber gasket is used between the faces of part 1 and 3, and in making connections with this coupling, part 1 having a female end, may be attached directly to the pipe line without the expense of a pipe coupling.

The couplings are manufactured in both malleable iron and brass by the American Engineering Works, of Chicago.—*Engineering and Mining Journal.*

The Miller Air or Liquid Pump.

In the *Iron Age* of July 23, 1896, was described and illustrated very completely the Chaquette air compressor built at Bridgeport, Conn. This was the most stupendous effort ever made to capture that *ignus fatuus,* perpetual motion, or to obtain something for nothing. In theory it was false from the foundation up; in design it possessed many beautiful features; as a mechanical construction it was gigantic; and as an investment it cost $100,000; the result, it was sold under the hammer and brought less than $5,000 as junk.

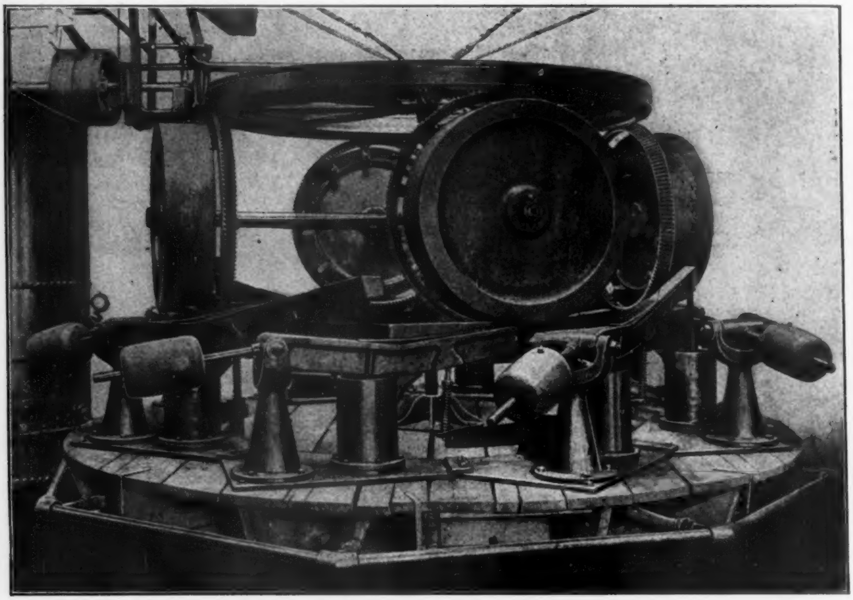
The explanation of its action was refreshingly simple and remarkable for its muddy lucidity. A heavy weight rolled along a path could be made to do a little work and never know the difference. This was demonstrated by loading a truck, driving a few nails part way into the floor, then blindfolding a man and having him draw the truck over the nails, which were forced entirely into the floor by the wheels. The secret was revealed and Dame Nature was astounded at the audacity of an experiment which revealed her inmost laws. Man, full of wisdom and knowledge even when blindfolded, could not detect when the wheel drove the nail into the floor; ergo, how could a lump of iron, not a sentient being, perceive what man could not? Therefore, since neither the man nor the truck knew they had done any work in driving nails, they had lost no power.*

The principle having been demonstrated and, incidentally, sufficient capital having been secured, it was only necessary to put the idea to practical use and, again incidentally, of course, gather in the shekels. So the men of Bridgeport made them a motor that was to run everything in the town except the Mayor. Mechanically, it was a splendid piece of work, made upon the interchangeable plan although repairs would never be needed, no variation of more than one-quarter of a thousandth allowed, bearings scraped to a fit, and so on. But there was one serious drawback—the thing wouldn't work. That was its only disadvantage; in all other aspects it was simply dear (lovely and $100,000 here implied). A big tank which had been made to hold the compressed air and the talents of gold and of silver, never had an ounce of the one nor a grain of the others in its midst. So the promoters fell down, the company fell down and the machine fell under the hammer. Peace to its scrap.

*These experiments were actually performed and were used as an argument in favor of the correctness of the Chaquette theory—that a moving mass could be made to do work and not lose any of its power.

The machine consisted of a horizontally disposed circular frame over 80 feet in diameter. This frame was formed with ten spokes, each of which carried at its outer end a cast iron wheel weighing some 15 tons, or 150 tons for all the wheels. These wheels were loosely mounted on their journals and traveled around a track. The frame was mounted on a pivot at its center and was turned by an engine through suitable gearing. In the path of the wheels were placed 100 air compressors, 50 within and 50 without the circle. These were arranged in pairs and the pistons of each pair were connected to the same lever. The levers were placed in the path of the heavy wheels and were so disposed as to be operated by them in their travel around the circle. The levers resembled the walking beams of a steamboat except that they had a piston at each end. At each revolution of the frame there were 200 strokes of the pistons.

The scheme will now be understood. Here was a weight of 150 tons, not counting the frame, moving along a level path. This great weight would actuate the levers and the compressors thereby be brought into operation. The boiler supplying the engine by which the frame was moved was only an incident. It was to be used only to start the machine and run it until the tank had been filled with air at a certain pressure. Then it was to be cut out and the air used to drive the engine.



THE MILLER AIR OR LIQUID PUMP.

It is only at this point of our story that the wonderful simplicity and transcendant money making power of the plan come into evidence. Mr. Chaquette said that out of 100 horse-power generated by the machine he only required 5-horse-power, or 5 per cent., to run the machine. He therefore had 95 horse-power out of every 100 produced to sell to the power consumers of Bridgeport and the rest of the United States. This meant that if you gave him 1 horse-power he would hand you back 19. Each one of these 19 horse-power could be made to yield another 19, and so on. This is a progressive

ratio, marvelous in its possibilities. A few of these plants, properly located, would do all the work of mankind, and there would still be enough power left to rock the cradle of industry.

But if Mr. Chaquette could return 19 for 1 why did he want even the 1? Why didn't he give 20 for nothing? Simply because he needed it in his business. He could multiply power—that was easy—but he could not overcome friction. Therefore he had to have just a little to run his machine because he did not know how to annihilate that bugbear, friction.

THE MILLER PUMP.

J. B. Miller, of Muncie, Ind., is not blushingly and retiringly modest in the claims he makes for his apparatus. The following simple statement explains the position of this invention: "I made the discovery many years ago where all power is lost." We first describe the machine, using information furnished by Mr. Miller as far as possible.

The machine, as shown in the engraving, is built on a platform upon which are placed eight iron plates for the eight pumps and posts to rest upon. The track is octagonal in shape and along each side is a lever, one end of which is attached to a pump plunger, which is 9 inches in diameter and has a 12-inch stroke. At the other end of each lever is a weight acting as a balance. The piston ends of the levers rise 12 inches above the track. Moving around the track are four wheels weighing together 14,000 pounds. On the shaft of each wheel is a bevel gear engaging a large bevel gear mounted on the central pivot and which is driven by a belt. In this way the four wheels are made to revolve around the track and operate the plungers.

The levers are balanced, we are told, as the beam on a pair of scales and "there is no power lost in this machine. All the actual power necessary to operate this machine is to roll these four wheels." Here is the inventor's explanation of this phenomenon: "Now for an illustration you can load a railroad car with 100,000 pounds and, having the car on a level track, you can take a pinch bar and start the car to moving, and after it is once started one man can keep it moving by pushing the same. Now take the weight of this 100,000 pounds as a power producer; it means 100,000 pounds power by the aid of one man power. This power producer is nothing more than a rolling weight." This is the Chaquette idea revivified as the late Mr. Keeley of motor fame would express it. "The machine now built is but 10 feet in diameter, while if it were 30 feet in diameter, so as to give the wheels greater momentum, the large machine could then be operated with less power than the small one." The wheels move forward and never find out that they are doing any work. The inventor claims that this machine will save at least 95 per cent. of the power now required by any other machine in use. The inventor does not claim any perpetual motion, he merely says that he has "accomplished some better things." "This machine could pump 800 gallons of water 50 feet high per minute with an expenditure of 3 horse-power." This means that with 3 horse-power this contrivance would actually exert 10 horse-power, as represented by the 800 gallons lifted 50 feet a minute. While this not perpetual motion it is a fine example of the multiplication of power; but this is a ratio of only 3 to 1 instead of 19 to 1. The Connecticut inventor still leads the Indiana inventor by a ratio of at least 6 to 1.

History repeats itself even in vagaries. These two machines are precisely alike, except as to unimportant details. Both depend upon heavy rolling weights which unknowingly operate pump pistons. In both the cylinders are arranged around a circular path, and for both extraordinarily absurd claims are advanced. History also repeats itself in the fact that bright men can be fooled in the most ridiculous way and, again incidentally, made to give up their dollars.—*Iron Age.*

A Little Story with a Moral.

The picture shown herewith illustrates a shed in which stands a 24 and 24¼ x 30" Class "A" Ingersoll-Sergeant Air Compressor.

This is the second attempt to work this well by compressed air, the first one proving entirely unsatisfactory, and as this factory is reported to have cost nearly one million dollars, and has always been crippled by lack of water, it has proved itself an exnpensive proposition. The water in the well stands 120 feet below

the surface, and when pumping, drops 190 feet.

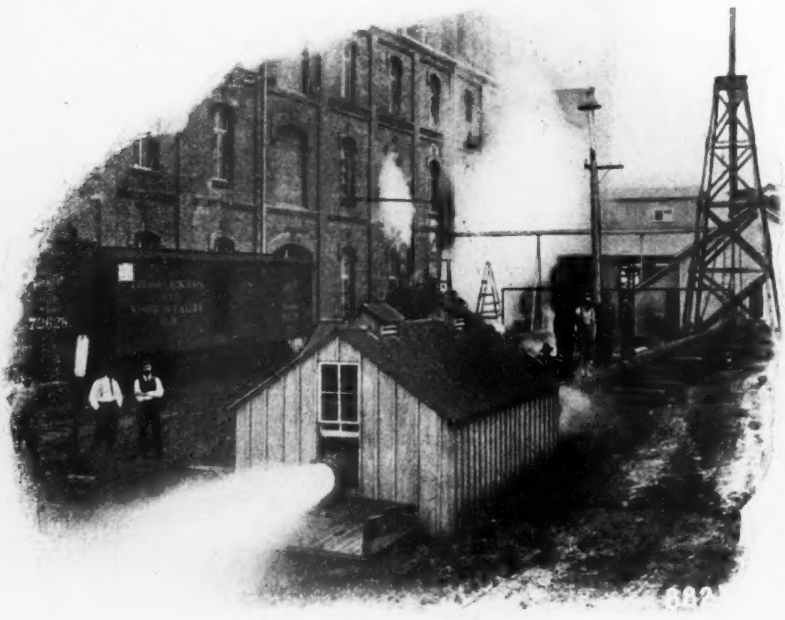
Having heard of the failure of the first air lift compressor to work properly, the writer paid a visit to this plant in order to investigate matters, finally making them a proposition to pump 1,000,000 gallons of water per day or no sale. This plan was accepted and the compressor shipped them. It took just half an hour for the compressor to demonstrate its ability and satisfy the would-be purchasers.

The air lift, scientifically applied, removed all trouble in this particular case. Applied wrong, it put them to much expense for nothing, and caused the abandonment of the well as of no value, though it had cost a large sum originally.

Moral: Use the air lift, but do it right.

From the photo you will note that the stream of water is as large as a man's body, the diameter of the stream at the point of discharge being 14 inches. Flowing down a trench it made a stream 43 inches wide by 4½ inches deep, moving 100 ft. per minute.

H. P.



AIR LIFTING 1,000,000 GALLONS IN 24 HOURS.

Compressed Air.*

In English Mines—Arrangements Which Result in Losses, and the Methods of Overcoming Them.

In transmitting and distributing energy by means of compressed air; we find exactly the same conditions as with other physical agents; we have to generate heat in the act of compression, and we transmit the power most economically, the more nearly we dissipate the whole of the heat as it is generated. Compressed air tends to genterate heat during transmission, and this rise in temperature should be avoided for economical reasons.

Again, the heat generated by the agent in the operation of transmission, which in this case is due to friction, obeys the law—the friction and the attendant heat vary inversely as the size of the conductor. On the one hand it is possible, where the power to be transmited is limited, and the distance over which it is

* Written for *Mines and Minerals* by Sidney F. Walker.

to be transmitted is also limited, to arrange so that the loss due to friction and the atendant conversion into heat, is practically negligible; and on the other hand, if both the power and the distance to be worked over are large, the friction of the pipes, and the conversion into heat from that friction may easily be so great that, not only is the final efficiency of the system very low, but conditions may even arise where the whole of the pressure will be wiped out by the friction of the pipes, and the whole of the energy generated in the cylinder of the driving engine will have been uselessly expended in heat in the pipes themselves. This case is the analogue to that of the horse which is only able to lift his own weight, and to that of the rope system, in which all the power is expended in friction and where heat is again uselessly generated. These cases are by no means fancy ones.

An examination of colliery working will reveal many instances where, if the power is not actually all swallowed up in the transmission, very little is left for work at the face, or wherever it is to be used. Taking the case of large powers at long distances from the generating plant, we have conditions, which are now rapidly maturing in the coal mines of the United Kingdom. The mines are getting deeper, the distances, over which haulage and pumping have to be done, are getting larger, because the area worked by one pair of pits is increasing in extent, and the problems which arise are assuming serious proportions in consequence. In the writer's opinion, though electricity has gone ahead very much recently, to a large extent from this cause, if compressed-air engineers will tackle the problem in the same way in which the electrical men have tackled it, by careful measurement, compressed air will not only have a good show, but it has more than a chance of being *the* power, for coal mines at least.

This leads at once to the question how is it to be done; and to the answer, by the same means by which the electrical men have attacked the problem—by increasing the pressures, and by providing conductors—pipes for the conveyance of the air—properly proportioned to the power they have to carry; further, by eliminating the water which is in the air before it arrives at the motors, by reheating the air also before it is delivered to the motors, and by redesigning the motors to take full advantage of the properties of air.

Up to the present, in the United Kingdom at any rate, the problem of transmission by compressed air has really hardly been atacked in the way it should be. Instead of calculating the sizes of pipes, and other accessories, it has been assumed that, say a 6-inch or a 7-inch pipe would deliver sufficient air for that purpose, or if the machine was short of air a larger one was necessary, and that was an end of the matter.

In a description of a large compressed-air plant, which was given in a prize essay in one of the technical papers in this country, careful measurements were made upon the working of the plant, and then the curious result was observed—curious to the writer of the essay apparently, but a result which might have easily been forecast by a simple calculation—that while the pressure, at the throttle valve of the engine using compressed air, was 52 pounds when the engine was at rest, as soon as the engine commenced to do its work the pressure went down to 40 pounds, 30 pounds, and finally to 20 pounds, while for a short period, during which the engine was doing work at a rather rapid rate, the pressure went down to 18 pounds per square inch.

The further curious result followed. The compressor at bank was arranged to deliver compressed air to the receiver at bank at 52 pounds, but when the haulage engine was working, in the manner described, the pressure it was able to maintain was only 40 pounds, and that only by increasing its speed from 20 revolutions per minute to 26 revolutions. And yet the author of the essay in question does not appear to have seen that this was evidence of extremely bad design. He is fully alive to the fact that the reduction of the pressure from 40 pounds to 20 pounds doubles the quantity of air to be delivered to the engine, to enable it to perform certain work, and that this increase of the quantity of air also increased the friction very rapidly, while the efficiency of the plant was reduced as low as 15 per cent. and in coal cutting machines worked from the same air supply to 12 per cent. It is easy to conceive of circumstances in this particular case, where the pressure and the efficiency would have been completely wiped out.

It is a practice in most British collieries to add machine to machine, in fact it is a practice pretty nearly everywhere, where they do not stop to calculate, pile on the load till something refuses to work, then add more power, and so on. It would only have been necessary to have had one other machine, say a coal-cutting machine, taking power freely, and therefore making a large demand for air from the compressed-air service, to have had the pressure so much lowered that practically nothing would have been done till some of the work had been taken off. It must be remembered that, with a pipe of a given size, the frictional charge acts in a compound ratio. The friction first lowers the pressure, that increases the quantity of air passing, and the velocity at which it is passing, and as the friction increases as the square of the velocity, the increased quantity of air passing adds very much to the frictional charge and to the reduction in pressure.

The whole thing points to the higher pressures. Figure upon it well before actually setting to work. In the case mentioned, the pipes in the shaft and on the roads were 7 inches in diameter, and doubtless the original contractors thought that they were providing amply. Those pipes ought to pass air enough for anything. But as the sequel showed they did not. If the pipes had been of sufficient area to pass the whole of the air with only a negligible loss, the efficiency of the system would have increased at least 30 per cent., but in that case it would have been necessary to increase the size of the pipes very considerably.

On the other hand, if the pressure had been doubled, the quantity of air would have been halved for the same work, and the frictional charge reduced by 75 per cent. for the same size of pipe. Assuming an initial pressure of 100 pounds, in place of 50 pounds, the loss in pressure corresponding to the work that was being done by the engine should not have exceeded 5 pounds in the 7-inch pipes, the air, therefore, arriving at the engine at a pressure of 95 pounds. But at this pressure the quantity of air would be again reduced, to a little over one-fifth that of the quantity required with the 20 pounds pressure, so that the loss by friction would be wiped out, or the pipes themselves could be considerably reduced in section.

For mining work, the reduction of the size of the pipes is in itself a great boon. Mines are subject to constant working, creeping, etc., which acts upon the pipes, tending to open the joints, to start leaks etc. With smaller pipes the tendency to this will be less, while the pipes themselves can be made stronger, as they are smaller, to meet the working of the mine and the increased pressure.

In the writer's opinion, the increase of pressure should be carried much higher than the figure given above. There is not the same danger in doing so as there is with electricity, and there should be no difficulty in carrying out an installation at 200 pounds pressure, with care in designing, and in execution. Pipes and joints would have to be carefully made, and leakage would have to be guarded against. At the present time, in the British collieries, it is leakage which is the cause of the major part of the low efficiencies, which electrical men are so fond of parading. Leakage affects the matter in two ways; it wastes the air and lowers the efficiency of the system. A certain power is expended in compressing a certain quantity of air, and if a percentage of the air is lost on its way to the motor engine, it is equivalent to that percentage of the power being lost; and in addition, the leakage uselessly increases the frictional charge made by the pipes behind it.

But it should be as easy to preserve good pipes, with proper joints, in a mine, as it is to preserve pipes, which stand high pressures in refrigerating apparatus in carbonic-acid refrigerating apparatus, for instance, the pipes are tested to a pressure of 3,000 pounds per square inch, they have to stand a regular pressure in work of 1,300 pounds, and the pipes are made up into coils of 2,000 feet in length. Surely it should be possible to make pipes which will stand a pressure of 200 pounds and to make joints which will stand that pressure and the creep of the mine as well. It is also worth considering whether it is not possible to make pipes which are slightly flexible, so as to give to the creep of the mine. Very tough steel should meet the requirements.

Another point that is worth considering is the possibility of forming a complete circuit with the compressed air pipe—the engine to exhaust into a receiver, from which the compressor would draw its supply. This, which is not a new idea by

any means, would get over some of the difficulties, while necessarily introducing others. Thus, there would be two sets of pipes to fix, instead of one, but this would not be a serious matter if the two pipes were small. Also the friction of the second set of pipes would have to be added to the first, in calculating the loss, as the compressor would have to draw the supply of air through them, in opposition to the friction of their inner surfaces, just as it has to force the air outwards, in opposition to the friction of the outgoing pipes. Such an arrangement would get rid of all possibility of trouble from moisture, as, once eliminated, it should not get into the air again, and it should place at the command of the engineer the possibility of working at higher pressures, without incurring all the loss of compression to the higher pressure. Thus, the exhaust could be at any pressure the engineer chose, and the work could be done between the two pressures, the quantity of air being in proportion.

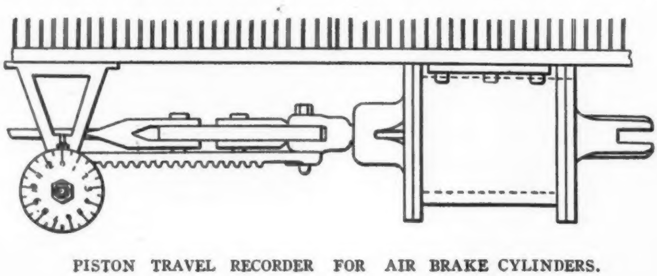
It is also worth considering whether reheating might not be carried out by means of electric currents, the air being caused to pass through coils of wire, or some similar arrangement, at a high temperature. The heat required is not large, and though this method would not be so economical as a simple coke fire, it would be much safer. Some years ago the writer carried out something of the kind in connection with an engine working at a pit bottom, and driven with compressed air, the engine itself driving an electric-light machine. This was in the very early days of electric lighting. The trouble was the usual one of ice in the exhaust ports, and this was stopped completely by wrapping a wire round the air pipe just before it entered the cylinder, and through which a current was allowed to pass. The writer has not figures as to the economy of the arrangement, but it did the trick.

The suggestion to use higher pressures will probably be objected to, as low pressures are more economical. So they are when you can use them. Nothing has yet beaten the old Cornish pumping engine—on its own ground—yet it is nowhere beside a Worthington Triple Expansion pumping engine, in work for which the latter is adopted. It is the old tale, the equation is right, and infallible when you have all the terms on both sides.

The writer has not entered into the question of efficiency, as it has been so fully discussed, but he is of opinion that, if all the items are taken into account, including all costs and high pressures are used, compressed air will show at least as well as any other agent for mining work.

Piston Travel Recorder for Air Brake Cylinders.

The importance of a device for registering maximum piston travel on air brake cylinders is indicated by the necessity of maintaining uniform piston travel. Not only does unequal piston travel cause slid flat wheels but it is oftentimes the cause of trains breaking in two, due to a short piston travel on rear of trains, both in freight and passenger service, where the trains are very long. By the installation of a device whereby car inspectors may adjust the brakes, every car will be made to do its proportional part of the braking, the breaking power of the whole train will be increased and the amount of air used will be reduced.



PISTON TRAVEL RECORDER FOR AIR BRAKE CYLINDERS.

Such a device is shown in the accompanying line drawing. With this device, which always registers the maximum piston travel, the amount of travel may be seen at a glance at the attached dial, which is so placed as to be seen from either side of the car. The dial is balanced so that shocks which cars might receive in switching have no tendency to change its position. The construction and operation of the appliance is such that when the piston travels out it effects a rotary motion in the dial in one direction only. When brakes have been adjusted the car inspector simply turns the dial back to O, and by observing the dial when the application of air is made, the travel of the piston is readily seen indicated on the face of the dial.

The device was originated by Mr. Frank Robinson, division foreman of the Maine Central Railroad, to whom we are indebted for the information and drawing. —*Railway Master Mechanic.*

Portable Oil Rivet Forge.

This forge is indispensable in connection with pneumatic riveters, and is used throughout the country in all the leading shipyards, boiler works and structural steel plants.

It carries a high, soft, uniform heat, and is always under control of the operator and the rivets are always in plain sight, quickly heated and easily reached. The forge will heat up to 1½ ins. diameter and on the average of 500 per hour, and with an oil consumption of from one to two gallons per hour, depending on the number of rivets heated.

Compressed air at 15 lbs. pressure or higher is required to operate this forge and with a volume of from 15 to 20 cubic feet per minute.

Fuel oil or kerosene can be used for fuel.

This forge is manufactured by Rockwell Engineering Co., 26 Cortlandt street, New York. They also manufacture fuel oil burning appliances and furnaces for every purpose.

PORTABLE OIL RIVET FORGE.

The Pneumatic Fire Fighting Tower.

This is the latest addition to the equipment of the Pittsburg Fire Department. The apparatus, says the New York *Tribune*, consists of four ladders, each mounted on a tube. The carriage is also provided with a tank containing an acid fire extinguisher, a small hose about 200 ft. long, and a large hose about the same length, as well as axes, lanterns, crowbars, and a standpipe, to which can be attached three sets of hose. But the extension of the ladders is the novelty in this mechanical creation. The four ladders are attached to steel tubes, which telescope into each other. These are mounted on a steel tank, which contains the air. The pressure carried is 200 lbs., and is supplied at the engine-house. The ladders can be raised and lowered with 50 lbs. of air, and are equal to about six lifts before the pressure has to be replenished. To do this the machine has to be taken back to the engine-house. But it is supposed that it will only be necessary to raise the ladders once or twice at each fire. The whole is mounted on steel trucks. When the ladders are to be raised the standpipe is erected by pneumatic pressure. In front of the air tank is a small air tank which contains a piston. The piston rod from this air tank is connected with the ladders, and as a valve is opened the ladders begin to rise by the plunger forcing the tubes with the ladders upright from the inclined position. The lift is supplemented by chains on the ends of the ladders, which pull while the ends of the ladder are down. After the standpipe is upright a fireman climbs up to the top of the first elevation, which is stationary after it is erected, and supports the tubes on the inside. By opening a valve the air pressure is admitted under the first tube, and it is raised to its full length, 20 feet. A second valve permits the raising of the second joint of tubing, and the third the same, there being a separate valve for each section. It is the custom to fasten a man to the top section before it is hoisted. He can take a line of hose, hook it to the ladder, and have it raised with him. With other extension ladders hose has to be carried up by hand. This ladder standing in the air will permit a fireman to play water into a window without having to have his ladder against the building, so that the flames shooting from a window will not scorch the firemen. In Germany there are aerial trucks carrying ladders that can be raised 150 ft. high. They consists of additional telescopic tubes. These tubes are polished, and are greased as they are raised and lowered by automatic means, and act much as the plunger or piston in an air pump. There is no limit to the strength of the ladders, as they will hold as many men as can be placed on the rungs.

Notes.

With air compressed to 100 pounds gauge pressure 1 cubic foot corresponds to 7.82 cubic feet free air; at 80 pounds pressure, to 6.46 cubic feet; at 60 pounds, 5.10.

Compressor explosions may be due to the use of an inferior oil or the use of too much good oil. Any deposit of oil on the parts of the compressor should be removed.

Mr. T. C. E. Hunter, of the Compressed Air Machinery Company, of San Francisco, recently secured a contract for a 120 H. P. compressor plant for A. C. Brokaw, of Quartz Valley, Cal.

We acknowledge the receipt of a small pamphlet on air compressors, in which is illustrated several types of steam and belt driven conmpressors, being introduced by Herron & Bury Mfg. Co., Erie, Pa.

At the Dusseldorf exhibition, which has just terminated, the highest award of merit, the gold medal, was awarded the "Hunt" conveyor. This conveyor is manufactured by the C. W. Hunt Co., West New Brighton, New York.

The Chicago Pneumatic Tool Co. (Fisher Building, Chicago, and 95 Liberty street, New York) issues a new catalogue of 72 pages, devoted to a description of air compressors made at the Franklin (Pennsylvania) works.

Like a bombshell in the ranks of Scotch toolmakers came the announcement, recently, that the American Pneumatic Tool trust has acquired extensive lands near

Fraserburg, and would immediately begin there the erection of machine and tool works.

The Christensen Engineering Company of Milwaukee have just completed the foundation of a 250-foot extension to their main machine shop, which is 186 feet wide. The new building will be three stories and will provide 88,000 additional square feet of floor space.

The new Allis-Chalmers shops at West Allis are approaching completion so far as exterior is concerned. Recently the large floor plate in machine shop No. 1 was completed. It is practically a perfectly level platform, 25 feet wide and 200 feet long, and grooved at intervals of every foot.

An air compressor at 3,000 feet altitude, to furnish air for twenty-five 2½ inch rock drills in rock of ordinary hardness, the drills being 2,000 feet from the compressor, would require 272 H. P.; a duplex air compressor with 18-inch steam cylinders; 20-inch air cylinders; 24-inch stroke, making 175 strokes per minute.

Air drills are supposed to be supplied with air at pressures between 60 and 100 pounds per square inch, and the best results are obtained only when the compressor is working against the pressure for which it was designed. The practice of allowing the drills to draw the pressure down below sixty pounds in the receiver is to be strongly condemned.

A new company, called the British Compressed Air Cleaning Co. Ltd., was registered Oct. 10, by Pains & Co., No. 14 St. Helene Pl., E. C., London, having a capital, they say, of £22,500. This company will turn to account patents relating to the cleaning, disinfecting and restoring of carpets, curtains, upholstery, furniture, fabrics and materials, and will carry on the general business of a cleaning works.

Two enterprising builders of Battle Creek, Mich., have been awarded the contract for erecting the new factories of the Advance Pump and Compressor Co. to be located on South Division street, adjacent to the Michigan Central Ry., and running back on Flint street. The buildings will be rushed forward to completion if possible by the first of the year and will be an ornament to the city as well as a credit to the strong company that will use them.

A new hoisting engine, built by the Sullivan Machinery Co., has lately put in an appearance at the Savoy-Sibley shaft of the Oliver Iron Mining Co.'s Mine near Ely, Minn. Special features of this machine are its two sets of auxiliary brakes, one set being operated by compressed air and the other by a hand wheel on the engineer's platform. Another advantage of the brake gear is the automatic pressure valve, which will automatically substitute air for steam, or steam for air, in the case of failure of either operating medium.

Mr. S. S. Caskey, who for a number of years past has been the superintendent of mechanical instruction with the Harlan & Hollingsworth Co., has accepted a position with the F. F. Slocomb Co., of Wilmington, Del. Mr. Caskey is a recognized expert in pneumatic engineering, and is the inventor of a number of well known appliances in this line, among the number being the Caskey Portable Pneumatic Punch, and the Caskey Pneumatic Riveter, both of which are manufactured, with all latest improvements, by the Slocomb Company.

Cars swept by compressed air. The railways in some places use compressed air for car cleaning. At the end of the cleaning tracks there is a large tank where the air is stored, and it is conveyed to the place needed through a rubber hose. The air emerges from the nozzle, not in a round stream as in a watering hose, but through a device known as a comb. It is an orifice several inches long, out of which the air emerges in a jet perhaps a thirty-second of an inch in width. It is not employed every time a car is to be cleaned, but only occasionally, being so effective that the alternate overhaulings are little more than dustings.

Most blasting experiments with liquid air have proved failures, but the results seem to have been better in recent bridge building work at Munich. Paper cartridges were filled with a spongy absorbent and provided with a detonator. When ready for the blast the liquid air

was brought to the spot in a vacuum-jacket vessel, and the cartridges were plunged into it until the absorption was thought to be sufficient. The cartridges were then quickly placed and fired by electricity or other means. The effects seemed to equal those of dynamite. Cartridges failing to explode become harmless in 15 minutes from evaporation of the air.

The Ship Owner's Dry Dock Co., of Chicago, made some very quick repairs on the "City of Rome." They estimate that they have saved one week in time over that usually required on such a job, by means of the compressed air tools and other methods of work employed, says the Marine Review. They put in a new stearn, new forefoot, part of her keel, new garboards and several new planks, besides calking all over. The company is more than pleased with the dispatch obtained with the new air tools, as it enables vessel owners to get their repairs done in much less time than is usual with wooden vessels, and the point is one that will be generally appreciated as soon as it is known.

The Christensen Engineering Company, of Milwaukee, Wis., is issuing some very handsome catalogues. One of these, a pamphlet of 52 pages, describes the Christensen air brakes for use on electrical railways, and contains views of the company's air-brake shops and a long list of electrical railway companies using the brakes. Another pamphlet, containing 54 pages, describes the company's "Ceco" electrical machinery, including direct current motors and generators, and alternating current generators and transformers. The descriptions are clear and concise and the half-tone cuts of unusual excellence. Still another catalogue, a pamphlet of 58 pages, describes the company's straight air-brake equipments with independent power compressors for use on electric cars.

It has been whispered among the ladies that a substitute for the old powder puff has recently been patented by Marie L. Gumaer of New York city. This new device consists of a perforated face-plate of any soft fabric stretched on a frame and connected with the metallic disk at the rear by a band of chamois leather, inside which is a coiled spring serving normally to hold the disks apart. The handle screws into the center of the base, and is removed to insert the powder in the puff. In operation the perforated surface is pressed against the skin, when the compression of the air inside and consequent discharge through the perforations drive the powder out also, causing it to adhere to the surface against which the puff is placed.

Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, sailed Tuesday, November 4th, for Europe. He expects to spend about four weeks on the Continent and states that it is his intention to establish, either in England or Scotland, a new plant for the manufacture of pneumatic tools. The design of this new plant will be practically the same as that of the factory now being operated by his company at Detroit, Michigan, which is the finest equipped manufacturing establishment of its kind in the world.

This move was made necessary by the large increase in the amount of business received by this company from England during the past few months and is a sure indication of the fact that pneumatic appliances are gradually becoming invaluable to the European trade as well as to the various industries of this country.

There is a quiet revolution going on at the present time, and very little is being said about it. Had this revolution taken place at the beginning of the last century we would probably have had warm discussions at the meetings of the trade guilds, followed by a meeting round the market cross and then an angry assembly round the gates of shipbuilding and boiler-making establishments. The maker and inventor of the first spinning Jenny had his machine broken and burned, while he had to fly for his life, and if the same conditions obtained now as then the makers of pneumatic chisels, hammers and air-driven drills would have their workshops burned about their ears. All that is changed now. Systems of pipes are being laid throughout every shipyard to carry compressed air to the portable machines driven by it, and the men like the system, for they have simply to hold the

chisel against the work in order that it may be chipped to the dimension they may wish.

Recently Street Cleaning Commissioner Woodbury made an official test of the new "Squeegee" outfit on the asphalt pavement near Madison Square, New York. The squeegee is operated in conjunction with a compressed air sprinkler which does not flood the surface, but allows to fall like a gentle rain a well-distributed spray.

The compressor takes precedence in line of procession only over the now feared squeegee, which is practically a towel which wipes off the face of the street, leaving it dry and clear.

This was thought to be especially advantageous to the automobiles and a number were on hand to experiment. The results, according to hearsay, are as follows:

"Six automobiles were on hand. Their chauffeurs shivering in the thirty-second degree of atmospheric chilliness, put the autos through their poses over the squeegeed surface.

"But alas! The frost had got in its fine work, and a thin coating of ice was formed to the dismay of the automobilists. Their machines 'skidded for fair'—cut Philadelphia grapevines, figure eights and all kinds of curly kews. The Commissioner had maintained that once a squeegee was used no known auto would misbehave.

"But the frost, he hadn't figured on. Now, he is figuring out a heating device which will be used co-jointly with the squeegee—this will make it a squeezizzer."

A midget motor power engine has made its appearance at Washington, creating much interest and also no little amusement. Though tiny enough to be carried in a small hat-box, yet it is powerful enough to run a steam launch.

This little rotary engine can be used any place where power is needed, and can be run by steam, compressed air, or water, or with gas or liquefied air. In fact, there is scarcely any machinery from a farm implement to a steamship which cannot be run by this little motor. It has been tried in automobiles, and runs smoothly and without the slightest vibration of the vehicle such as is experienced in most of the machines.

There is no flywheel such as would interfere with the general application of its power and it can be used in propelling airships. It has been used in the generation of electricity on a large scale, but acted equally well when for house lighting it was worked by water pressure from an ordinary spigot.

During its operation in the navy department it was illustrated that the little circular affair, scarcely bigger than a wash basin, could, while in any position whatever, whether vertical or otherwise, be used with the same advantage as when standing in its proper position on the base constructed for it. The inventors of the motor, Nicholas Jean Fortunesco, a Roumanian, and Alfred Georges, a Belgian, have just had American patents issued to them on the machine.

Senator George G. Vest, of Missouri, is in Baltimore, and has placed himself in the hands of Dr. Henry F. Garey, the specialist and inventor of the ophthalmic oscillator.

Senator Vest's sight is so seriously impaired that he requires the services of an attendant in order to get about. He is suffering from a disease of the retina of the eye.

Compressed air is the important thing in Dr. Garey's treatment. An electric motor compresses the air. Two rubber tubes attached to the air reservoir have on the ends two glass cups which fit down close over the face and touch the eyeballs.

The daily treatment which Senator Vest will receive is interesting. The glass cups first are pressed against the head at the base of the brain. There are two apertures in the surface of the cups, through one of which air under considerable pressure is forced against the head. Through the other air is drawn in. Thus the surface to which the device is applied is agitated, something like massage. This is continued for four minutes. Then the cups are fitted over the eyeballs and the same operation performed on them. The treatment is not painful.

The application to the back of the head acts as a stimulant to the blood vessels which supply the optic nerve. The application to the eyeball, which acts directly on the optic nerve, produces a sort of friction on the nerve further back than any other treatment that has ever been tried.

If there is a spark of life remaining in the nerve it may be restored to its normal condition. Senator Vest has not received sufficient treatment as yet for improvement to be noted.

W. A. Coles, the blind entertainer of Boston, came to Dr. Garey for treatment last month and is showing marked improvement.

A writer in the *National Engineer,* in connection with cooling water by means of compressed air, says the cold, expanded pipe should only be led through a pipe or coil of pipe dipped into the water to be cooled, then exhausted into the atmosphere, and recalls a fact of personal experience when in charge of some tunnel work. A ventilator fan blowing fresh air to the front was actuated by a small steam engine working with compressed air, the exhaust of which was led into a closed chest containing tin tumblers filled with water. On its way to the discharge orifice the current of air was passing along the row of tumblers, and some ten to fifteen pounds of ice were thus daily made quite readily. The miners felt interested in the progress of the refrigeration, and the men of the outgoing shift would seldom fail to dip a dusty finger into some of the tumblers, whose main peculiarity was the existence of a black core at the center of the block of ice.

The air which has done expansive work behind a piston moving in a cylinder escapes at a low temperature and at a moderate speed, and is fit for use as a refrigerating agent. In the air which is simply released through a valve the whole expansive work is converted into velocity and almost instantaneously transformed into heat by friction with the surrounding atmosphere or against the neighboring bodies. The result is that no cold can practically be produced in this manner.

Besides, the use of an expansion cylinder coupled to the compressing cylinder reduces to a minimum the actual amount of work required by this process of refrigeration. Its efficiency is low, and it is not economical on a large scale, as compared with the ammonia process; but it possesses advantages of simplicity, of cheapness and of safety which in many cases will make it quite valuable.

The editor of the *Petroleum and Industrial Review* writes as follows:

"Is the air compressor useless for oil? This is a question which naturally rises to one's mind on reading the contradictory reports which emanate from various fields. In regard to the air compressors in use in the Russian fields we hear little about them. It has, we know, been stated that the output of certain wells, where the compressor has displaced the baler or pump, has been considerably increased. On the other hand, quite the contrary is reported from another quarter, in an article by Mr. Nagel, in recent issues of this paper. According to his account the cost of exploiting a well by baling amounts to 391 roubles per month, raising 4,000 poods of oil and 2,000 poods of water per 24 hours, working out at 0·326 copecs per pood. When, however, the air compressor is used, the writer of the article states that the cost per month would amount to 1,108 to 1,365 roubles, or ·92 to 1.14 copecs per pood. But in giving these figures, the writer of the report has not taken into consideration that the air compressor can always raise a larger quantity oil than the baler, which means in regard to the figures given that a much larger production could be obtained for the same outlay. Moreover, Mr. Nagel has omitted to take into account that one air compressor is capable of raising oil from two wells at the same time, thus reducing the cost very considerably.

In regard to the American fields, the air compressor is apparently regarded as a useful and profitable apparatus there, although we have no definite figures to go on, while reports from the Texas fields are also contradictory, and we should, for the benefit of all interested in petroleum exploitation, like to have further data on the matter.

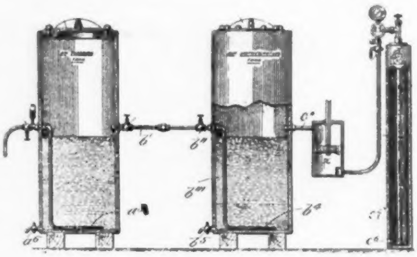
Mr. Peter Brotherhood, the mechanical engineer who, by the invention of a new type of steam engine, and afterwards of a special high-pressure air-compressing pump, greatly assisted in the development of the automobile torpedo, died at his residence, 15 Hyde Park gardens, on Monday afternoon. He was in his 65th year, having been born at Maidenhead in 1838, the son of Rowland Brotherhood, rail-

way contractor, of Chippenham, Wilts. Having passed through a four years' applied science course at King's College, he received a practical training in several egnineering works, including the Great Western Locomotive Works at Swindon, and Messrs. Maudslay, Sons, and Field's marine engineering establishment at Lambeth, and began business on his own account in 1867, his present works by the riverside near Westminster bridge being opened in 1881. It was in 1872 that he invented the special engine with which his name has since been identified. It has three cylinders set at angles of 120 deg. round a central chamber, and all three connecting rods operated upon one crank within the central chamber. When exhibited at the Vienna Exhibition in 1873, it aroused great interest, and its first application as a steam motor was for driving dynamos and also centrifugal pumps in the French warship Richelieu. The Woolwich authorities recognized that, if arranged for working with compressed air, it would be greatly superior to the ordinary vertical oscillating cylinder engine then in use in Whitehead torpedoes, the new motor admirably accommodating itself to the limited and circular section of the torpedo. The first Brotherhood three-cylinder air engine made for this purpose proved a success, and it has since been applied almost universally for torpedoes. It has also been adapted for hydraulic power, and is largely used for capstans. As a steam engine, however, it has been supplanted by high-speed engines of the vertical type using steam expansively in two or more cylinders. Mr. Brotherhood also introduced important improvements in the pumps for compressing air on board ship for use in torpedoes, and his compressors have been largely used in British and foreign ships since first applied in the first British torpedo boat "Lightning." He also invented a vertical direct-acting engine, the first of which was made in the remarkably short period of 27 working days, for Queen Victoria's yacht—the "Victoria and Albert," in special circumstances. Mr. Brotherhood took little part in public life, being entirely devoted to his engineering work. He is survived by a widow, two daughters, and one son.

U.S. PATENTS GRANTED OCT. 1902

Specially prepared for COMPRESSED AIR.

710,404. METHOD OF TREATING AIR FOR FORCING MALT LIQUORS FROM KEGS. Charles A. Bartliff, St. Louis, Mo. Filed April 20, 1901. Serial No. 56,696.



The method of treating air for use in forcing malt liquors from kegs, which consists in heavily impregnating said air with hops, compressing the same and maintaining the same in a compressed condition in contact with a preparation of hops.

The method of treating air for use in forcing malt liquors from kegs, which consists in heavily impregnating said air with hops, compressing same, and storing the air while compressed in a suitable receptacle having a solution of hops, where it remains in contact with hops until drawn from said receptacle for use.

710,480. AUTOMATIC AIR-VALVE FOR WATER-MAINS. Christian E. Loetzer, Towanda, Pa. Filed Dec. 28, 1901. Serial No. 87,574.

An automatic air-valve for water-mains comprising a chamber having a lower water-inlet passage, a cup-like seat within said chamber above said passage having a lateral water-port, an air-vent tube depending within said chamber, and a hollow open-bottom float fitting within said cup-like seat, said float having an upper tube constantly fitting said air-vent tube and adapted to close and open communication therewith as the float rises and falls according to the height of water in the chamber.

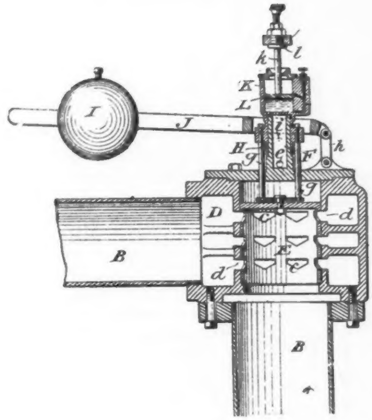
710,514. FLEXIBLE PIPING FOR THE AIR, STEAM OR OTHER PIPING FOR RAILWAY-CARS. George Riexinger, Buffalo, N. Y. Filed April 25, 1902. Serial No. 104,647.

In railway-cars, a metallic, flexible, connecting-piping consisting, essentially, of a T-shaped member attached to the stop-cock of the air and other pipes, a sleeve and lock-nut on the T end of this pipe, a main member having two forks as described, a cross-piece in one of these forks, an auxiliary pipe having a fork connected with said cross-piece, and a slip-joint member attached to said auxiliary member.

710,522. AUTOMATIC SAFETY-LOCK FOR AIR-BRAKE SYSTEMS. William H. Sauvage, Denver, Colo., assignor of one-fifth to Richard McKnight, Denver, Colo. Filed Feb. 14, 1902. Serial No. 94,147.

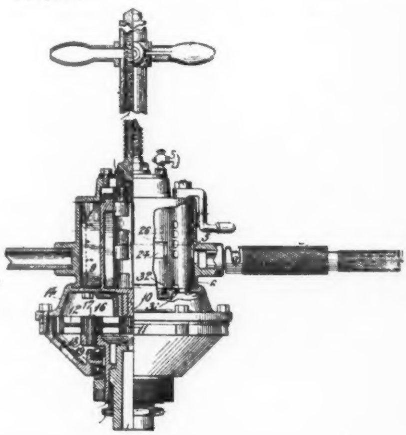
An automatic air-brake locking device for air-brake systems of railway-trains, the combination with the auxiliary reservoir, the brake-cylinder and its piston, of air-brake systems of a supplementary cylinder arranged in juxtaposition to said brake-cylinder, a piston and piston-rod operatively arranged in said supplementary cylinder, a compressed-air pipe connected between one end of said supplementary cylinder and said auxiliary reservoir and a compressed-air-pipe connection between the opposite end of said supplementary cylinder and the air train-pipe of said air-brake system, and means connected with the piston of said supplementary cylinder and the piston of said brake-cylinder, including a gripping device for automatically gripping and locking said brake-cylinder's piston in operative set-brake position.

710,712. REGULATOR FOR AIR-COMPRESSORS. William Prellwitz, Easton, Pa., assignor to the Ingersoll-Sergeant Drill Company, New York, N. Y., a Corporation of West Virginia. Filed Nov. 13, 1901. Serial No. 82,073.



The combination with a valve for closing or choking the inlet to a compressor, of a stationary cylinder to which there is an inlet from the receiver to which the compressor delivers, a movable outer cylinder fitted to the exterior of said stationary cylinder, connections between said outer cylinder and the valve, and a double-acting liquid dash-pot the cylinder of which is carried by said movable cylinder and the piston of which has a stationary support.

710,782. PORTABLE PNEUMATIC ROTARY DRILL. Julius Keller, Philadelphia, Pa., assignor to Philadelphia Pneumatic Tool Company, a Corporation of New Jersey. Filed Aug. 13, 1902. Serial No. 119,479.



A portable pneumatic drill, a cylinder, a rotary engine therein, an inlet-passage for the motive fluid, a plurality of chambers intermediate said passage and engine, an upright reversing-valve arranged parallel to the axis of said engine and located intermediate of said passage and chambers, and an exhaust-chamber below said cylinder, said reversing-valve exhausting downwardly directly into said exhaust-chamber, and serving to simultaneously connect either of said passages with the inlet-passage and the other with the exhaust-chamber.

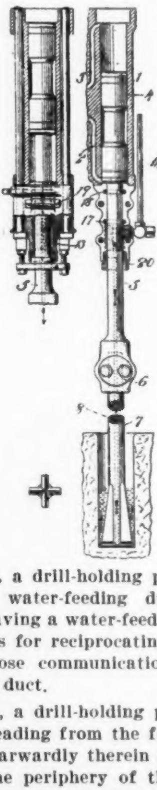
710,855. PNEUMATIC SAND-FLUE AND NETTING CLEANER. Robert W. Gibson, Palestine, Tex., and William N. Best, Los Angeles, Cal., assignors of one-half to John H. Best and Ezra Best, Quincy, Ill. Filed Dec. 4, 1901. Serial No. 84,705.

A sand-flue and netting cleaner, comprising a sand-receptacle, a discharge-pipe, a pipe leading from the receptacle to the discharge-pipe, and connecting said parts together for conducting sand to the discharge pipe, an injector-nozzle, and means for controlling the discharges through said parts.

710,889. COMPRESSED-AIR RESERVOIR. Thomas D. Prescott, Philadelphia, and James C. Prescott and Henry A. Prescott, Minersville, Pa., assignors of one-fifth to Henry Bell, Philadelphia, Pa. Filed Aug. 27, 1901. Serial No. 73,494.

A compressed-air-storing device, comprising in combination, a closed cylinder having fixed upper and lower heads, an inlet-pipe connected to the lower head, a check-valve in said pipe, a valved discharge-pipe also leading into the lower end of the cylinder, a piston fitting snugly within the cylinder, a piston-rod extending out through a guiding-opening in the upper cylinder-head and provided with a threaded upper end, a spider comprising a central hub and a series of equidistant radially-projecting arms, each having at the outer end a vertically-disposed bolt-receiving opening, upper and lower nuts carried by the threaded upper end of the piston-rod and engaging respectively with the upper and lower sides of the spider-hub, thereby to permit of the vertical adjustment of said spider on the piston, and the upper nut serving not only to lock the spider in position but to maintain the same in a horizontal plane by clamping it against the lower nut, a series of eyebolts adapted one to each of the openings in the spider-arms and having upper and lower adjusting nuts, a series of coiled springs of equal size and strength, having their upper ends connected to the eyebolts, a base supporting the cylinder, fixed eyes carried by said base and in alignment with the spider-arms, the lower ends of said springs being secured to said fixed eyes.

710,922. ROCK-DRILLING MACHINE. William Prellwitz, Easton, Pa., assignor to the Ingersoll-Sergeant Drill Company, New York, N. Y., a Corporation of West Virginia. Filed Jan. 7, 1902. Serial No. 88,739.



A cylinder, a drill-holding piston having a longitudinal water-feeding duct therein, a front head having a water-feed chamber therein and means for reciprocating the piston to open and close communication between the chamber and duct.

A cylinder, a drill-holding piston having a water-duct leading from the front end of the piston-rod rearwardly therein and thence outwardly to the periphery of the rod, a front head having a water-feed chamber surrounding the piston-rod and means for reciprocating the piston to bring the duct into and out of communication with the water-feed chamber for feeding water intermittently to the drill.

711,116. HOOD FOR PNEUMATIC STRAW-STACKERS. George M. Michell, Earlham, Iowa. Filed March 28, 1902. Serial No. 100,387.

An enlarged, tapering and open-bottomed end for a tubular conveyor for straw-stackers or separators, a hood hinged to the top of the free open and enlarged end and means for adjusting the hood, arranged and combined to operate in the manner set forth for the purposes stated.

711,158. PNEUMATIC MOTOR FOR MECHANICAL MUSICAL INSTRUMENTS. Henry F. Hall, Cambridge, Mass. Filed Sept. 12, 1901. Serial No. 75,241.

A pneumatic motor for mechanical musical instruments and the like, the combination of a main block having a series of longitudinal channels therein, a series of pneumatics mounted on one face of said block and communicating with said channels, a second block provided with a series of channels forming continuations of said longitudinal channels and terminating in ports opening in the side of said second block, a chamber in said second block connected with a wind-chest and having orifices adjacent to the said ports, and a rotary valve engaging the side of said second block to control communication between the pneumatic and the wind-chest.

711,367. TERMINAL FOR PNEUMATIC-DESPATCH TUBES. Fred R. Taisey, Indianapolis, Ind., assignor to the Taisey Pneumatic Service Company, Indianapolis, Ind., a Corporation of Indiana. Filed Oct. 17, 1901. Serial No. 78.965.

A pneumatic-despatch apparatus, an air-conduit with a curve in it and an enlargement at the curve, and a discharge passage-way for the carrier located in and of less diameter than such enlargement and extending tangentially with the curve of the conduit.

A pneumatic-despatch apparatus, an air-conduit with a curve in it, and a perforated discharge passage-way for the carrier located within the air-conduit and extending tangentially with the curve thereof, said conduit being enlarged about the perforated portion of said discharge passage-way.

711,369. PAPER-BAG MACHINE. James West, St. Louis, Mo., assignor, by mesne assignments, to the Union Paper Bag Machine Company, Philadelphia, Pa., a Corporation of Pennsylvania. Filed June 28, 1900. Serial No. 21,883.

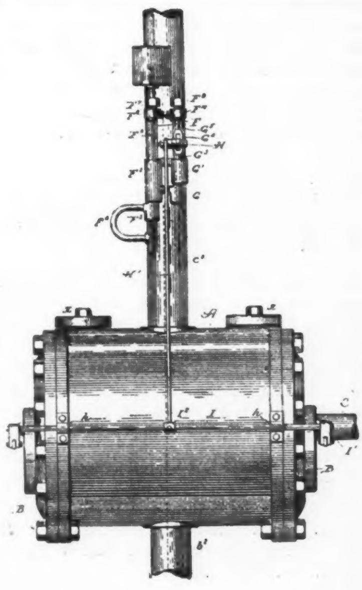
A machine of the class described, means for directing a blast of air against a bag to open up the sides thereof, in combination with folders for bending back the corners of the bag.

A machine of the class described, the combination of means for directing a blast of air against the bag to open up the sides thereof, means for folding back the corners of the bag, and means for pressing the sides of the bag down onto the corners.

711,597. MACHINERY FOR THE PRODUCTION OF LIQUID UNDER PRESSURE. Adolf Vogt and Max von Recklinghausen, Westminster, London, England. Filed June 25, 1901. Serial No. 66,007.

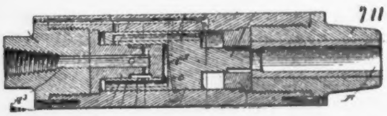
A machine as described, an explosion-chamber, a high-pressure and a low-pressure chamber one above the other surrounding the explosion-chamber and containing liquid, means connecting the high and low pressure chambers, a motor interposed in said means and valves controlling communication between the explosion and high and low pressure chambers, and means to ignite the charge, whereby liquid will be forced into the high-pressure chamber through the motor and low-pressure chamber up into the explosion-chamber again to compress the charge.

711,689. COMPRESSOR. Frederick Wittenmeier, Chicago, Ill., assignor to Kroeschell Brothers Ice Machine Company, Chicago, Ill., a Corporation of Illinois. Filed Feb. 15, 1902. Serial No. 94,283.



A compressor, means for unloading the compressor-piston when the pressure-supply pumped by said piston is excessive, comprising a supplemental opening in the cylinder end, a valve at said opening and means for opening said valve comprising a chamber G', a passage extending from the compression side of the compressor to said chamber, a movable diaphragm in said chamber operatively connected with said supplemental-opening valve, a weighted passage opening and closing valve F5, and lever mechanism connected with said diaphragm and supplemental-opening valve, all constructed to operate substantially as set forth.

711,859. PNEUMATIC TOOL. William M. Holden, Barre, Vt. Filed Dec. 24, 1900. Serial No. 40,939.



The combination with the casing or cylinder having exhaust-ports, and an inlet-head for the motive agent rigid with the cylinder, of the tool-operating piston having a head in front of said inlet-head and a sleeve extending rearwardly over said inlet-head and forming a recess or chamber between the inlet-head and the head of the piston, the inlet-head and piston having inlet-ports arranged to conduct the motive agent to the opposite ends of the piston and to the recess or chamber between the inlet-head and the piston-head.

711,940. PNEUMATIC ALARM FOR AUTOMOBILES. Gaston E. Cordeau, Brooklyn, N. Y. Filed Oct. 30, 1901. Serial No. 80,478.

A pneumatic alarm for automobiles, a pump, means for operating said pump by the foot and a sounding device connected to said pump by an elastic bulb.

A pneumatic alarm for automobiles, an air-pump, means for fastening said pump to underneath the body of the vehicle, a sleeve, having means for fastening to the footboard of said vehicle, and a rod slidably fitted within said sleeve.

712,249. AIR-BRAKE. Joseph B. Briggs, Jr., Russellville, Ky. Filed March 22, 1902. Serial No. 99,491.

An air-brake system having an air-release valve arranged between the angle-cock valve and the coupling at the free end of the hose-section, to release the air-pressure from the hose and comprising a separate casing secured in the angle-cock casing.

712,401. COMPRESSED-AIR WATER-ELEVATOR. Willard McKee, Charleston, W. Va. Filed April 10, 1902. Serial No. 102,-211.

A water-elevator comprising the pair of pumping-chambers having inlet and discharge openings, the floats operating in said chambers, the operating-valves, means for operating said valves by their respective floats, the main valves and the controlling-valve, the casings provided with chambers for said valves and with feed and exhaust ports and with ports or channels for the passage of compressed air through the controlling and main valves to the pumping-chamber and for the passage of pressure controlled by the position of the operating-valves for moving the controlling-valve and main valves into different positions.